THE

TREATMENT OF DISEASE BY CLIMATE

GENERAL BALNEOTHERAPEUTICS

VON ZIEMSSEN'S
HANDBOOK
OF
GENERAL THERAPEUTICS

IN SEVEN VOLUMES—VOL. IV.

THE TREATMENT OF DISEASE BY CLIMATE

BY

DR HERMANN WEBER

GENERAL BALNEOTHERAPEUTICS

BY

PROFESSOR OTTO LEICHTENSTERN

LONDON
SMITH, ELDER, & CO., 15 WATERLOO PLACE
1885

THE

TREATMENT OF DISEASE BY CLIMATE

BY

HERMANN WEBER, M.D., F.R.C.P. Lond.

TRANSLATED FROM THE GERMAN

BY

HEINRICH PORT, M.D., M.R.C.P. Lond.

PHYSICIAN TO THE GERMAN HOSPITAL, LONDON, ETC.

GENERAL BALNEOTHERAPEUTICS

BY

DR OTTO LEICHTENSTERN

TRANSLATED FROM THE GERMAN

BY

JOHN MACPHERSON, M.D.

INSPECTOR-GENERAL OF HOSPITALS (RETIRED)

LONDON

SMITH, ELDER, & CO., 15 WATERLOO PLACE

1885

TRANSLATOR'S PREFACE

TO

TREATMENT OF DISEASE BY CLIMATE.

THE subject of 'climate' is such a very wide one that it seems difficult to comprise it within anything like moderate limits. Dr. Hermann Weber, whose great experience is well known, has, however, accomplished his task with great success, though on a good many points he would, no doubt, have liked to say a great deal more, had he not been hampered by space.

An exhaustive work on climate has still to be written, and a task like this can hardly be fulfilled by one man, but must have many contributors.

As regards the translation, there are doubtless many shortcomings, but it at least gives a true rendering of the original text.

H. PORT.

TRANSLATOR'S PREFACE

TO

GENERAL BALNEOTHERAPEUTICS.

The Translator at first thought of adding numerous notes to the text, referring to non-German wells, which meet with comparatively slight notice in Dr. Leichtenstern's work; but on further consideration it was apparent, that it was not the Author's purpose to enter into details, but chiefly to lay down the great principles of Balneology. This he has done with marked success, while sweeping away, in a clear, trenchant, and somewhat unceremonious manner, various time-honoured bath beliefs, which still linger in England, as well as on the Continent.

The Translator has endeavoured to follow his Author as closely as possible, and cannot venture to hope that he has not occasionally fallen into Germanisms, and he has at times employed language perhaps too familiar in style for a scientific work. It has been found necessary to use various bath words, such as *Cur*, in a half-German sense, but this is of no great importance in these days, when the phrases of German balneology are well known in England.

For brevity's sake the word 'therapy' has been frequently used instead of 'therapeutics.'

The centigrade degrees of temperature have been converted into degrees Fahrenheit.

The metrical system is retained, as in the original.

JOHN MACPHERSON.

CONTENTS

OF

THE FOURTH VOLUME.

TREATMENT OF DISEASE BY CLIMATE.

II.

CLASSIFICATION OF CLIMATES.

III.

THE CHOICE OF A CLIMATE FOR THE TREATMENT OR PREVENTION OF DISEASE.

GENERAL BALNEOTHERAPEUTICS.

PAGE

THIRD PART.

APPENDIX.

PAGE

SYNOPSIS

OF THE EMPIRICAL INDICATIONS OF DIFFERENT DRINKING AND BATHING CURES IN INDIVIDUAL DISEASES.

THE

TREATMENT OF DISEASE BY CLIMATE.

BY

HERMANN WEBER, M.D., F.R.C.P. Lond.

PHYSICIAN TO THE GERMAN HOSPITAL, LONDON, ETC.

TRANSLATED BY

HEINRICH PORT, M.D., M.R.C.P. Lond.

PHYSICIAN TO THE GERMAN HOSPITAL, LONDON, ETC.

TREATMENT OF DISEASE BY CLIMATE.

Definition of climate.

UNDER the term climate we understand the combined result of the influences exercised by air, soil, and water on organic life in any given locality.

Elements of climate.

The principal elements which combine in the formation of these conditions must be sought for in the air, or atmosphere, and particularly in its composition, its amount of heat, moisture, and light, its density, currents, and varieties of electrical condition. These elements should not be regarded as distinct from each other, but as intimately combined. We might express ourselves as follows: The sun, owing to the heat and light given off from it, is the principal agent in exciting those terrestrial and atmospheric conditions which are modified by the rotation of the earth around the sun and on its own axis.

Causes determining the character of a climate.

The character of the climate of a given place is chiefly determined by (1) its distance from the equator; (2) its height above the sea; (3) its position with reference to the sea or large inland lakes, hot deserts, or cold regions; (4) the prevailing winds; (5) the nature of the soil, the configuration of the surface, and the aspect of the place; (6) the cultivation of the soil, the state of population and civilisation.

The object of climatotherapeutics.

The object of climatotherapeutics is the preservation of health and the treatment of disease by climate. It goes hand in hand with dietetic, hygienic, and,

where necessary, medicinal treatment. A mere glance at the health and mortality statistics for different seasons, and under different conditions of weather, shows the influence of different climatic factors on the state of health of the population, and the different seasons represent to a certain extent different climates. Thus, when the weather is moderately cool, being at the same time moist and liable to more or less sudden changes, we observe the prevalence of rheumatic affections and of catarrhal and inflammatory states of the respiratory organs. At a still lower temperature of the air, without moisture, but more so with it, we notice that in temporarily or permanently weak subjects most of the functions of the body suffer, and that in aged people apoplexies become more frequent. In hot weather there appears a tendency to diarrhœa and to other diseases of the abdominal organs. On the other hand, we find that during the mild or moderately warm and not too damp weather of the second half of spring and beginning of summer many chronic affections, particularly chronic catarrhs and chronic rheumatisms, improve considerably, and that weakly people gain in appetite and digestive power, blood formation, and muscular force. We notice also that persons with chronic catarrh and emphysema suffer less during the prevalence of warm and moist weather, and are more able to undergo fatigue, whilst many subjects with chronic dyspepsia, and tendency to depression of spirits and hypochondriasis, always feel better and seem like quite different persons when the temperature is moderately cold and there is a clear sky with sunshine. To remove persons to climatic conditions in which the influences of certain seasons hurtful to them are as far as possible absent, but where the favourable influences of other seasons prevail, is the chief object of climatic treatment.

Sources of climato-therapeutics.

It follows that treatment by climate is based on climatology—that is, the science which deals with the different climates of the earth's surface and their effects on man in health and disease. Climatology, however, is a very extensive subject, is as yet in its infancy, and is based on other and likewise undeveloped branches of science, particularly aerology, meteorology, physical geography, and comparative geographical physiology and pathology.

That change of climate as a remedial agent was already familiar to the physicians of antiquity is evidenced by the well-known saying of Hippocrates (in his treatise 'De Morbis Vulgaribus'), 'In morbis longis solum vertere conducit.' Also in other works of the same author we repeatedly come across passages showing the importance which he attached to climatic conditions ; for instance, in the book 'De Aëre, Locis et Aquis' and in the 'Aphorisms.' There are other facts which prove that the ancients used climate for the treatment of disease. Thus Aretæus recommended sea voyages and a residence at the seaside in phthisis ; Galen treated the same disease by (a kind of) mountain climate combined with milk diet; Celsus, like Aretæus, by sea voyages and sea climates; and the elder Pliny was of opinion that consumptive patients would be more benefited by residing in pine woods ('silvas eas dumtaxat, quæ picis resinæque gratia radantur') than by a sea voyage to Egypt or by the milk treatment in mountain districts. Again, in the later writings of Roman and Arabian physicians climate is sometimes alluded to as an important factor in the origination and treatment of disease, and the same may be said of the medical works of the Middle Ages and of later times; but the beginning of scientific climatology and of climatotherapeutics dates merely from the nineteenth century. We may consider Alexander von Humboldt as the founder of recent climatology, on which scientific treatment by climate is based. Humboldt's writings roused the interest of scientists in France, Germany, and England by proving the influence of meteorological and climatic elements on the fauna and flora. So many excellent works have been published since then that we find it impossible to pass them all in review in a short treatise like the present.

Historical summary.

In England and France copious statistic material is contained in the reports (often exceedingly able) on the sanitary condition of the army and navy in the different colonies. In both countries, too, meteorology and climatology have been much advanced by monographs and articles in periodicals. It will suffice to mention the names of Gregory, Morton, Sir James Clark, Archibald Smith, Francis, Scoresby-Jackson, Sir Ranald Martin, Livingstone, Glaisher, Buchan, Tyndall, Frankland, Angus

Smith, Henry Bennet, C. J. B. Williams, C. T. Williams, and Marcet.

In France and French Switzerland important contributions have been furnished by Gay-Lussac, De Saussure, senior and junior, Boussingault, Arago, Becquerel, Boudin, Levy, Ch. Martins, Lombard, Jourdanet, Guilbert, Carrière, De Pietra-Santa, Schnepp, Rochard, Borius, Le Roy de Méricourt, Gigot-Suard, Fonssagrive, Armand, and many others.

In Germany and German Switzerland since the time of Humboldt we must particularly mention Berghaus, Kaemtz, the brothers Schlagintweit, Dove, Mühry, A. Hirsch, v. Sigmund, Vivenot, Tschudi, Küchenmeister, Schmidt, Müller, Brehmer, Lorenz and Rothe, Richter, Hann, C. Brügge, Beneke, H. Reimer, Rohden, Spengler, Biermann, Thomas, Krieger, Volland, and Ludwig.

Classification.

In dealing with the extensive material at our disposal we shall proceed as follows:—

I. We shall consider the different elements or factors of climate and the more important modifying influences.

II. We shall attempt a classification of the various climates, giving under each head a short account of the regions and places suitable for the treatment of invalids.

III. We shall point out the use of these places in the climatic treatment of certain morbid conditions and tendencies.

IV. A chapter will be devoted to the consideration of the manner in which climatic and hygienic treatment may be carried out without sending the patient far away.

I.

ELEMENTS OR FACTORS OF CLIMATE.

I. *THE ATMOSPHERE OR AIR.*

Composition of the air.

By far the most important of the factors of climate is the atmosphere—*aër pabulum vitæ*—partly owing to its composition and partly because almost all the other climatic elements are conveyed by it.

Until lately it was thought sufficient to assume that the air is of the same composition everywhere ; but a more accurate investigation has proved the existence of small differences not only in the relative proportions of the main ingredients, but chiefly in the admixtures, more or less constant, which have great influence on organic life. Angus Smith [1] has done good service in climatology by his investigations in this department, and he rightly points out that even apparently slight changes and foreign admixtures are of the greatest importance, because the quantity of air inspired is extremely large, as can easily be calculated. Though we cannot call the air an article of food in the ordinary sense, it is at all events by far our most important and indispensable means of existence. Angus Smith points out that we lay great stress on changes in drinking water, although in comparison with air we take up but small quantities of it. We may add that in the alimentary canal certain injurious effects of the water may be modified by the digestive juices, and we may likewise destroy them by boiling, filtering, and by admixtures, and that, to a certain degree, we can make ourselves independent of the water in our immediate surroundings by using other liquids, whilst we are compelled to take in, by twelve or more inspirations every minute, large

[1] *Air and Rain*, by Robert Angus Smith. London, Longmans, 1872.

quantities of the air around us, which in the lungs comes into close contact with the blood, without having undergone a chemical purification in its passage. Though, owing to the exchange of gases, only certain constituents of the air enter the blood, and not the air as a whole, the action of poisonous gases furnishes us with many proofs how quickly they enter. If we consider the large surface by which the blood comes in contact with the air, the delicacy of the membranes of the smallest blood vessels, the rapid circulation of the blood, and the great quantity of the latter, this need not cause much surprise. As regards the minute particles mixed with the air, a large portion of them is certainly deposited in the upper part of the respiratory passages (nose, larynx, and the larger bronchi), but a portion has been proved to reach the finest ramifications of the bronchi and the air cells. Formerly there was a disposition to trust, in false security, to an assumed complete filtration in the long respiratory passages, and Tyndall and Lister have shown that the spores are absent from the portion of the air last expired; but even if we assume a complete filtration in the case of healthy lungs, we have scarcely a right to do so in the case of diseased respiratory organs. Respirators made of charcoal (Stenhouse), or better still of cotton wool (Tyndall), and other filters for the inspired air, as recommended, may suffice in a limited number of cases, but would hardly avail in daily life to counteract what we may call the chronic impurity of air.

As regards the composition of the air, we can only glance at some points most important to the physician, and must refer to works on the atmosphere for detailed information.

According to Regnault, Bunsen, Dalton, Frankland, and Angus Smith the approximate relative proportion of the three chief ingredients of pure air is—

Oxygen	20·96	volumes
Nitrogen	79·00	,,
Carbonic acid	0·04	,,
Total .	100·00	,,

Besides the three factors just named we have to consider, as more or less ordinary ingredients, aqueous vapour, ozone,

chloride of sodium, ammonia, dust (inorganic and organic), and, under certain conditions, hydrochloric, nitric, and sulphuric acids.

Oxygen.

The difference in the proportion of oxygen as found at different places rarely amounts to more than a mere decimal fraction, but having regard to the large quantity of air which we inspire, even a very small difference is of great importance, more particularly as any deficiency of oxygen is always replaced by other ingredients more or less noxious, such as carbonic acid and other substances. According to Angus Smith the air in open spaces at Manchester contains 20·943 per cent.; in enclosed places surrounded by houses and smoke, from 20·6 to 20·87; and in the neighbourhood of localities abounding in putrefaction, 20·7 per cent. Similar differences are to be found in different parts of London:—

	Place	Oxygen per Cent.
N.W.	Near Belsize Park	21·010
S.	Kennington Park	20·940
S.W.	Chelsea Hospital, gardens near river . .	20·910
S.W.	Vauxhall Bridge, near river . . .	20·965
S.W.	Houses of Parliament, terrace . . .	20·945
W.	Hyde Park, Sloane Street	20·925
W.	Middle of Hyde Park	21·005
	Average . .	20·95

	Average
In more densely inhabited parts of the S. and S.W. .	20·883 per cent.
In parts situated in the thickly populated E. . . .	20·86 ,,

A. Smith found, on repeated analyses, not inconsiderable differences at the same place in Manchester in different states of the weather.

In very wet weather	20·98 per cent.
In dry foggy and frosty weather, when the smoke had little exit from the town	20·89 ,,

The analyses of this chemist show also variations between the interior and exterior of houses.

Before the door of a house in a suburb of Manchester the air gave of oxygen	20·96 per cent.
In a sitting-room of the same house	20·89 ,,

The diminution of oxygen in badly ventilated and overcrowded localities, such as theatres, schools, &c., is, however, much greater, so that less than 20 per cent. of oxygen is frequently met with.

As an average of particularly good air at the sea shore and on open heaths (Scotland) A. Smith found 20·999 per cent.

Albert Leeds found by repeated analyses in Hoboken, United States of America, and in Philadelphia, on an average 20·962 per cent.

Nitrogen.

As regards the direct influence of *nitrogen* in the air on the organism we know but little; perhaps it represents simply a diluting medium of the oxygen.

Carbonic acid.

On the proportion of *carbonic acid* in the air, Horace de Saussure and his son Théodore first made more accurate observations, and found on an average in Geneva and its vicinity 4·9 in 10,000 parts (minimum 3·7, maximum 6·2); as a rule, less in winter than in summer, less in daytime than at night, less on an open meadow that in the town of Geneva, somewhat less over the middle of the Lake of Geneva than on an open meadow, less on a plain than in the mountains. These results coincide with those found by more recent observers. Messrs. H. and A. Schlagintweit, as well as Frankland, have found a larger amount of carbonic acid on high mountains. Thus Frankland[1] found at

	Oxygen.	Carbonic Acid.
Chamounix	20·894	0·063
The Grands Mulets	20·802	0·111
Summit of Mont Blanc . . .	20·963	0·061

Slight variations seem, however, to exist between different places. Pettenkofer found on an average in Munich 5 parts in 10,000 in the open air, and 6·8 in 10,000 in the interior of dwelling-houses; A. Smith, 3·7 in 10,000 in Manchester, 3·34 in Hyde Park, and 4·28 in Lower Thames Street, London. On the other hand, Pettenkofer shows that in schools, theatres, and badly ventilated bedrooms the quantity of carbonic acid may reach 20 and even 58 in 10,000; and A. Smith likewise found as an average in badly ventilated and crowded rooms 16 in 10,000, in some law courts in London even above 20.

[1] 'On the Composition of Air from Mont Blanc,' *Experimental Researches in Pure, Applied, and Physical Chemistry*, by Dr. Frankland, 1877, p. 477.

Thorpe found a small diminution in the amount of carbonic acid in sea air—3 and 3·2 in 10,000—and detected no difference between day and night.

The influence of carbonic acid on the organism.

Although the results of experience regarding the action of carbonic acid on the organism are abundant, their application to climatic conditions, where the quantity of carbonic acid has been found to be increased, is not very easy, as, together with the increase in carbonic acid, other noxious substances are augmented. If we enter a crowded room or a close bedroom, the sense of smell shows us at once that something else is present besides carbonic acid alone. We have repeatedly passed a considerable time in gaseous sool-baths containing over 3 per cent. of carbonic acid without experiencing any inconvenience; whilst in crowded rooms, where the air contains only 3 per thousand of carbonic acid, we are regularly attacked by headache, vertigo, nausea, &c. Decomposition of fermentative liquids, such as milk and urine, takes place much more quickly in crowded rooms, but not owing to the carbonic acid alone. *The increase in the proportion of carbonic acid in the air* may, however, to a certain degree serve as *a measure of the unsound condition of the locality or room*; and the results of experiments made in a place like London are supported by the analyses of A. Smith, Frankland ('dry fog'), and others. As an instance I may mention the difference observed in the complexion and general state of health in children when allowed to play in open parks instead of in streets or confined alleys, and further the circumstance that in the winter 1873, during some days of smoky fog, a number of animals brought to the Agricultural Exhibition soon perished by pulmonary affections. Persistent headache, nausea, and vomiting are not rare during the denser smoky fogs; increased cough and shortness of breath are almost constant under such conditions in patients affected with emphysema and chronic catarrh; depression of spirits is a general experience, and many other disturbances of health might be added, some of which are of a serious nature.

We will devote a chapter later on to the consideration of the conditions of aqueous vapour and the humidity of the air.

The properties, mode of origin, and value of ozone (dis-

covered by Schönlein) are still shrouded in some mystery; but it seems to be a gas important to climatology which is scarcely ever wanting in so called healthy air, although its relative quantity is invariably small—according to Houzeau at the most one part in 700,000. Most chemists consider it as an allotropic form of oxygen; according to Andrews, Sorel, Brodie, Odling, and C. Fox the formula is O_2O, each atom consisting of three atoms of oxygen, that of antozone (peroxide of hydrogen) being H_2O_2. Another view is that ordinary oxygen is split up by different agents—light, heat, humidity, evaporation, electricity—into negative and positive oxygen; that ozone is evolved at the positive and antozone at the negative pole; and that the formation of both takes place at the same time. Oxidation of every sort is effected by means of ozone, antozone being set free during the process. The latter is supposed to combine with aqueous vapour and to transform it into rain. This view, however, has not received general acceptance.

Ozone and antozone.

The modes of determining the amount of ozone in the air are still defective. Amongst much of uncertainty, some points, however, have been established—that it is absent near putrefying substances; that in hospital wards it is not found, although at a short distance it is present in the open air; that in the interior of towns the quantity of ozone is smaller than in the suburbs and in the country; that it is greater in the streets, outside the houses, than in the interior of rooms; that at the sea shore it is greater than inland, on mountains greater than in plains; that it is augmented by distributing fluids in showers, by quick evaporation in salt works (Gorup-Besanez, Lender), in rainy weather (and particularly during thunder storms), and by intense sunlight. Ozone, according to Frankland and other authors, possesses a greater disinfective and oxidising power than ordinary oxygen, which does not imply that every oxidation is effected by ozone.

Antozone is a less well-defined substance, and has, according to Engler and O. Nasse, but slight oxidising powers; but it seems to take a part in alterations in the state of aggregation of the molecules of water.

Common salt is almost invariably found in the air. It

Common salt.

occurs in greater quantities near to the sea than inland, being all but absent at any considerable elevation.

Ammonia.

Of Ammonia too there is nearly always a trace, but from a climatic point of view this gas is probably of less importance to animal organisms than to vegetable growth.

Dust.

The 'dust' in the air is of a very complex nature, and varies in quantity and composition at different times and in different places. The inorganic are the less important ingredients, and consist for the most part of minute particles derived from the soil, floating in the air, and carried away to enormous distances. They are made up of molecules of silica, chalk, iron, and other minerals, and added to them are particles of plants, animals, seeds, pollen, and innumerable spores, germs, eggs, and minute animals and plants which appear to live in the air.

Ehrenberg's classical investigations have, long ago, drawn attention to this subject; but it was Tyndall who, by experiments with the electric light, demonstrated clearly the endless quantity of the minute inhabitants of the air. His ingenious theories on the connection between dust and disease, and on the possible usefulness of some of these organisms in the purification of the atmosphere, in tissue change, and the formation of light, furnished important starting points for the elucidation of climatic conditions. Angus Smith, from the results of chemical experiments, arrived at the conclusion that a cubic foot of air in towns may contain 500,000 germs. It is possible that the proportion and nature of germs in the air will enable us in time to determine differences in the air of different regions. The admirable researches of Pasteur on fermentation and on the organised substances in the air ('Annales de Chimie et de Physique,' third series, vols. lii. and liv.) prove the great difference between the air of glaciers and that of inhabited districts.

Removal of impurities from the air.

The interesting questions concerning the removal from the air of the impurities constantly added to and developing in it must be left to aerology, although the chief agents effecting this purification, such as vegetation, winds, rain, and electricity, &c., are the real factors

of climate. We must also leave to hygiene the equally important considerations regarding the purity and dryness of the air in our dwelling-houses and rooms, though in recommending a suitable climate these questions have to be constantly taken into consideration, the best climate very often failing to do good without the help of well-arranged dwellings. Such men as Pettenkofer, Morin, Parkes, Du Chaumont, Maercker, Finkelnburg, Roth, Lex, and others, and also various architects and engineers, have done good service in elucidating these points, and their works contain many hints as to hygienic rules to be observed in daily life.

II. *THE WARMTH OF THE ATMOSPHERE.*

Next to the composition of the air, its temperature appears to us of most importance, partly because of the extent to which all organisms are affected by it, and partly because of the great influence it exerts over the other climatic factors.

Sources of warmth.

The sun is the chief source of heat for the earth's surface and the surrounding atmosphere, any warmth derived from the moon, or the stars, or from the interior of the earth being comparatively trifling. The atmosphere is heated (1) by direct radiation from the sun, (2) by radiation and reflection from the earth, (3) by conduction from the earth, and (4) by currents.

Direct radiation.

Direct radiation supplies only a small part of the heat, air being diathermanous for the sun's rays; that is, their heat passes through, and it is only owing to the presence of vapour that part of it is absorbed in the passage, this proportion being less in the upper and drier strata of the air than in the lower and moister strata. The quantity of heat thus absorbed varies according to the proportions of the vapour in the air. Winds have no effect on the course of the rays of heat.

Terrestrial radiation.

Radiation and reflection from the surface of the earth depends on the character of the surface, whether solid or liquid. A portion of the sun's heat not absorbed in the passage, varying with the nature of the surface on which the

rays fall, is immediately reflected and passes back into the atmosphere and into space; another part is absorbed, and after having been retained in the soil for a longer or shorter period the greater portion of it at least is again radiated into the air. These cooler rays are more or less completely absorbed by the atmosphere, and chiefly by its lower strata, these being the denser and containing a larger amount of aqueous vapour. Later on we shall return to the subject of the influence exercised by the fluid or solid surface on the absorption and radiation of heat.

The earth, being the warmer, transmits by conduction part of the heat it receives to the strata of the atmosphere in immediate contact with it. These strata expand, and, thus becoming lighter, rise, their place being taken by cooler and heavier air, so that gradually large quantities of air are heated in this way.

Direct conduction.

The rise of the warmer and the descent of the cooler air excites currents, which have a most important function in the atmosphere, as changes taking place at one point are transmitted by them to distant regions. As regards the distribution of heat (which alone we are treating of here), it is evident that the lower layers, heated and made lighter either by radiation or by conduction, are carried upwards by the currents, thus contributing to the heating of the upper layers. Again, by the air currents known to us as *winds* strata of air heated at places far distant, e.g. at the equator, are conveyed towards the poles. Thus they are important factors in

Currents.

The Distribution of Temperature in the Atmosphere.

The air would soon be raised to a high degree of temperature if cooling influences were not constantly present. Of these we may mention: firstly (and principally), the constant radiation of heat into space, the temperature of which is very low; secondly, the evaporation of liquids from the soil, from sheets of water, and from plants, more or less heat becoming constantly latent by this process; thirdly, when the earth, which loses its heat more readily than the atmosphere, has

Cooling influences.

become cooler than the air, the latter gives up its warmth both by radiation and direct contact—that is, by conduction.

Distribution of Heat on the Surface of the Earth.

We must refer our readers to other works for the consideration of the question how far the distribution of heat on the earth depends on its rotation round the sun and on its own axis. If the earth were a sphere with a level surface everywhere of uniform character, and if the atmosphere were without aqueous vapour, or if this were distributed equally, the latitude of any place would indicate to us the nature of its climate; but the variations in elevation, in the nature and clothing of the earth's surface, in the distribution of land and water, the varying amount of moisture in the atmosphere, and a great many other influences, produce considerable deviations from the climate to be expected from the latitude alone. We may, however, in a general way say, first of all, that in the vicinity of the equator, in a zone of unequal breadth (in the tropics), the mean temperature for the year amounts to about 80° or 83° F., and gradually decreases towards the poles; and, in the second place, that, as the distance from the equator increases, the contrast between summer and winter is greater, on account of the more vertical incidence of the sun's rays, and the longer duration of sunshine in the former and the inverse conditions in the latter.

According to the latitude.

Alexander von Humboldt was the first to represent on charts the distribution of temperature over different regions of the globe, and thus gave an impulse to the better study of the modifying influences of climate in general and the distribution of temperature in particular. He might be called the father of modern climatology. We are indebted to him for connecting together places having an equal mean annual temperature by lines which he called *isothermals*; those joining places having an equal mean winter temperature he called *isocheimals*, and those joining places having an equal summer temperature *isotherals* ('Kosmos,' vol. i. p. 341, 1845). The subject was further worked out by Berghaus and by Dove.

Isotherms.

To the latter we owe the *monthly isotherms*, which are of great importance to medical climatologists, and also the positive and negative *isanomal lines*. Were there no modifying causes in raising or lowering the temperature, all these lines would be parallel to the equator, whilst in reality they show great convexities and concavities. The charts above mentioned prove that the curves are far more irregular in their course in the northern hemisphere than in the southern; that in the southern hemisphere these isothermal lines become less sinuous the farther they are from the equator, because no longer under the influence of the continents of South America, Africa, and Australia. It has also been shown that in the northern hemisphere the summer and winter isothermal lines deviate considerably from the mean annual isothermals, those for the winter deviating towards the north over the Atlantic Ocean and Western Europe, owing to the Gulf Stream, but towards the equator in the large continents of Asia and North America, whilst for the summer the opposite holds good. In other words, we might say that the part of the Atlantic in question, and the islands and coasts of Western Europe, are warmer in winter and cooler in summer than would correspond with the mean annual isotherms. On the other hand, the North Asiatic continent is cooler in winter and hotter in summer. Again, in America the temperature is colder in winter and moderate in summer, May and September standing about midway. This mere sketch must, however, be rectified by a detailed inspection of the charts.

Causes other than Latitude which Modify Climate.

Of causes which tend to *raise the mean annual temperature* the following may be enumerated, as being the most important in moderate and high latitudes: the proximity to a warm ocean current; proximity to a western coast; the shape of a continent, if characterised by projecting peninsulas and deeply indented bays; the position of a country with reference to clear water towards the polar regions, or to a large continent in the same meridian

Causes raising the mean annual temperature.

towards the equator; the prevalence of winds blowing from warmer oceans or lands; chains of mountains acting as protecting walls against cold gusts of wind; finally, the constant clearness of the sky in the summer months (Humboldt).

An exhaustive discussion of these conditions would lead us too far. To some of them we shall have to refer later on, but for the present we will consider the influence of the ocean more in detail.

Water in its relations as to temperature.

The manner in which *water* is affected by the sun's rays on the one hand, and by land and the air over it on the other, is one of the most important agents in the formation of climates. The specific heat of water is considerably higher than that of the solid surface of the earth, the relative proportion being on the average about four to one. Water, accordingly, is heated more slowly, but retains heat for a longer time. It is penetrable by heat to a considerable depth, and this is another cause for the slow heating of its surface. Again, water being a bad conductor of heat, the latter is given off more slowly, and as the atmosphere over water always contains more aqueous vapour than elsewhere, the loss of heat by radiation is likewise diminished. The circumstance must also be taken into account that when by radiation or conduction water becomes cooled at the surface, it sinks and gives way to warmer fluid, so that during clear nights the cooling of the surface of water, and of the layer of the atmosphere above it, is not so considerable as that of the earth. According to Captain Thomas, the difference between the highest day temperature and the lowest night temperature of the surface of the sea near the coast of Scotland averages only 0·6° F., whereas on land it amounts to about 12°, the relative proportion being 5·5° to 72° F. So far the relations of sea water and fresh water are very much the same, but there is a great difference between the two at low temperatures. Fresh water, like other fluids, contracts in cooling and becomes heavier until it reaches 39·3°. With increasing cold it again expands, and just before congealing it has the same volume as at 46·5°. Sea water, on the other hand, freezes only at a temperature of about 28·4°, and its point of maximum density is still lower than this. It follows that sea water does not solidify into ice till it has almost cooled down to the

freezing point throughout its whole depth, whilst fresh water, when its temperature has become as low as 39·3° throughout, may become covered with ice, owing to its surface layers, which are becoming lighter, rapidly cooling. It is only the deeper inland lakes, therefore, which do not freeze during a severe frost.

Ocean currents.

The ocean in its relation to climate differs from calm inland lakes particularly by its *currents*, for the production of which similar agencies are at work as for the air currents or winds. Within the scope of the subject under consideration come particularly those currents which have their origin in hot countries, and bring the temperature of the latter to colder regions.

The Gulf Stream.

The current which is of the greatest importance as regards Europe, and at the same time most familiar to us, is the *Gulf Stream*. This is a part of the warm current flowing in the North Atlantic from the tropic and subtropic regions to the far North, and raising considerably the mean annual temperature of the western shores of Europe and of the adjacent isles. Its warming influence is particularly striking in winter at the British Isles, the western coast of Norway, in Iceland, and on the western shores of France. Thus, to take an example, the mean winter temperature of the Shetland Islands (lat. 60° N.), instead of being as low as 13° F., is in reality nearly 39°; and in the case of Bergen it is raised to about 34°, though otherwise the temperature would be yet lower than that of the Shetland Islands. The isochimenal of 32° passes through Iceland between the parallels of 63° and 65° N., and its winter temperature is therefore the same as for places situated in the middle of the European continent, 12° to 15° of latitude more to the south. This warming influence is effected not only by winds warmed by the Gulf Stream, but also by direct conduction from the warm water to the land, as is shown by the considerable mean difference in temperature between the western coast of Ireland and the interior of the island, amounting to almost 4·5° F. The Gulf Stream is therefore a true source of warmth for the western parts of Northern and Middle Europe; and wherever indented bays allow it to penetrate to a certain depth towards

the interior of a country, this latter comes likewise under its influence. The whole west of Europe has, to a certain extent, this fortunate configuration.

We must add that a warm ocean, without particular currents, exercises by itself a warming influence on the shores with which it comes in contact.

Among the causes which tend to lower the mean annual temperature Humboldt includes the following: the elevation of a locality above the level of the sea when not influenced by an extensive table land; the vicinity of an eastern coast in high and middle latitudes; the compact configuration of a continent having no littoral curvatures or deeply indented bays; the fact that a continent stretches away towards the poles without the intervention of a sea remaining open in the winter; the existence of a wide expanse of sea between any place and the equator; chains of mountains shutting off the access of prevailing warm winds; vast swamps or collections of stagnant water, which in higher latitudes are covered with ice till early summer; and, finally, a misty atmosphere in summer and a clear sky in winter.

Causes lowering the mean annual temperature.

In summer the vicinity of the sea exercises a cooling influence. Consequently the summer temperature is much lower on the islands of the west coast of Europe than in the interior of the continent, and this is even more striking as regards the islands of the southern hemisphere. The temperature of islands is further lowered in summer by the frequent cloudiness of the sky, or, in other words, by diminished insolation. Owing to the great preponderance of water over land in the southern hemisphere its mean annual temperature is somewhat lowered, according to Dove by about 3·015° F.

Cold ocean currents tend to lower the mean temperature in the same ratio as warm currents raise it. We instance the cold current on the west coast of Africa, Humboldt's current on the west coast of South America, and the Arctic current descending on the east coast of North America. The temperatures of the east coast of Asia and the south coast of Australia are likewise lowered by cold currents.

Cold ocean currents.

The influence of *large fresh-water lakes* is shown in a striking manner in North America (Lakes Superior, Huron, Erie,

Michigan, Ontario, &c.) They have a cooling effect in summer, so that the temperature of Fort Brady, situated near to the Lakes Superior, Michigan, and Erie, is only about 64·4° F. in July, whilst that of Fort Snelling, which lies westwards in the same latitude, is 73·4° F. When they are partly frozen in winter they impart a continental character to the North American winter.

Large inland lakes.

That the temperature falls with increasing elevation above the sea level is a fact generally acknowledged; but the rate of the decrease is not uniform. We shall return to this point later on in considering the climate of high altitudes, and for the present we will restrict ourselves to some of the principal points. According to Schlagintweit the decrease in ascending the Alps is about 1° F. for 315 or 320 feet; von Sonklar gives for the Austrian Alps 1° F. for 280 to 388 feet; and, according to Humboldt, the average in the case of Central America would be equal to 1° F. for 340 feet. The rate of decrease varies with seasons, times of the day, aspect, and other circumstances. On ascending in a balloon these conditions are modified to a considerable extent by air currents of different temperatures and strata of cloud and mist.

Fall of temperature with increasing height.

In the less elevated regions of the atmosphere the lower strata are not unfrequently colder than the upper, particularly at night, owing to the radiation from the earth and the descent of the colder strata of air.

The influence exercised by mountain chains in affording protection from certain winds is recognisable in the Scandinavian peninsula, in England, and in other places. Bergen, situated on the west coast of Norway, in lat. 60° 24′ N., according to Dove has a mean annual temperature of 46·75° F.; for the winter 36·3°, for the summer 58·6°, the difference between summer and winter being 22·26°. On the other hand, in Christiania, situated to the east of the mountain chain, in lat. 59° 55′ N., the mean annual temperature is 41·1° F.; for the winter 22·8°, for the summer 59·63°: difference between summer and winter, 36·81°. Similar relations exist between Bergen and Stockholm, and Bergen and Upsala. Bergen owes its mild, equable temperature in a great measure to warm and moist south-westerly winds. The moun-

Influence of mountain chains.

tains situated to the east deprive the winds of a certain amount of moisture and warmth in winter, and render them drier, but at the same time warmer, in summer; hence the easterly places have colder winters and warmer summers, and are drier.

Limited value of mean annual temperatures.

The mean annual temperature is of less value to the physician than the distribution of temperature over longer or shorter periods of the year, for places having the same mean annual temperature often differ materially in climate. A glance at Dove's meteorological tables will give us examples.

	Mean Annual Temperature (Fahr.)	Winter	Summer	Difference
Munich	48·35	32·49	63·63	31·14
Dublin	48·4	41·41	57·88	16·47
Odessa	49·39	28·2	70·61	42·41
Bergen	46·78	36·3	56·79	20·49
Potsdam	46·63	31·51	64·07	32·56
Fulda	46·89	27·36	65·62	38·26
Catherinoslaw (in Russia, Black Sea district) . .	46·9	20·71	70·56	49·85

Of greater consequence are the mean temperatures of the different seasons, and more so still those of the different months, as given in Dove's monthly isotherms, and also the difference between the succeeding months, weeks, and days. We must, however, study not only the mean monthly temperatures, but also the maxima and minima for each month and for each week, or, as suggested by Dove, for each period of five days, and also those for each single day. We have further to consider the distribution of temperature over the different hours of the day, so that we may be able to fix the hours that are to be spent in the open air. This last point is, in fact, of great importance, and should not be lost sight of before any particular climate is recommended, though we must admit most works on climate give only scanty information on that matter.

Influence of different degrees of temperature on the organism.

The influence of different degrees of temperature on man in health and disease has not yet been sufficiently examined. During the last few years, however, we have been enriched by several valuable results of physiological enquiry. Thus Pflüger ('Wärme und Oxy-

dation der lebendigen Materie,' *Pflüger's Archiv*, 1878) has shown that cold acts as an irritant, and that it increases the excretion of carbonic acid; and Voit's investigations (' Zeitschrift für Biologie,' vol. xiv. p. 59) have led to the same result. More remarkable at first sight is the fact observed by Pflüger that heat likewise increases the excretion of carbonic acid; but quite in accordance with it are the results of the experiments made by Marcet on the island of Teneriffe (' Proceedings of the Royal Society,' March 1879). Duke Carl Theodor has well demonstrated by experiments on cats ('Zeitschrift für Biologie,' vol. xiv. p. 51) that the continued action of cold, as in winter, tends to lower the excretion of carbonic acid, and that the change of tissue is less in summer and in a heated room than in winter and in a room not artificially heated; and that the same quantity of food, which in winter is just sufficient to keep up the bodily weight, will in summer lead to a considerable increase of weight.

The prevalent notions on this subject are based either on the influence of different seasons, or on the effects of a change from a cold to a hot climate, and, conversely, on observations recorded by travellers, or on the difference of races in different parts of the globe. In all these cases, however, varieties of temperature are not the sole agents, but the other climatic factors have also to be considered, together with the altered way of living, and frequently malaria and bad hygienic conditions. These additional circumstances are, as a rule, not sufficiently appreciated.

Tropical heat.

Thus it is often maintained that it is the heat in India which generates in Europeans the frequent affections of the liver and of the organs of digestion and of sanguification; but it should not be forgotten that the conditions of moisture, light, wind, and electricity are likewise different, and that Europeans do themselves harm by excessive use of nitrogenous food and of alcoholics or by unsuitable clothing, and that malaria prevails at many places. The increased mortality among children by diarrhœa, which occurs in the temperate zones during the summer months, is also mostly explained by the high temperature; but many cases of this disease are not caused by the direct action of heat on the body,

but by the changes produced by heat in milk, water, and other articles of food. We have often seen diarrhœa disappear as soon as the milk was kept in ice safes, and only water which had been boiled was used. The much lower mortality among children suckled at the breast is another proof in the same direction.

Parkes also, in his work on 'Hygiene,' expresses the opinion that among the English soldiers stationed in India, provided they conformed to the general rules of hygiene and avoided malarious districts, the mortality is not greater than in other colonies or in England. In our own experience we have seen repeatedly that excessive heat is well borne by the healthy for a limited space of time, unless the air is too damp, and provided cooling of the body by perspiration and evaporation can take place.

However, from the observations of Ranald Martin and others, it does not seem doubtful that continuous and excessive heat by day and night, from about 77° to 82° F., has a depressing effect on the nervous system and on the great functions of digestion, respiration, and sanguification. We must also allude to the observations made by Rattray on naval cadets, aged from 14½ to 17 years, the results of which showed that in the tropics these lads increased in height more rapidly than in cold climates, but that they lost weight and strength and suffered in general health.

Influence of moderate heat.

In the treatment of disease by climate, however, the influence of high degrees of temperature is much more rarely presented to us than the influence of moderate heat —from 54°. to 72° F.—compared with the effects of lower temperatures. At a moderate temperature, as met with in the early and late part of summer in the temperate zones, and during the cool season of warmer climates, the loss of heat is less than in winter, and *healthy* subjects experience a diminution of tissue change, take less food, and the functions of respiration, of circulation, and digestion, as well as the urinary secretion, are somewhat lessened, whilst the skin acts more than usual. They also show less vigour in the functions of the nervous system and in muscular action. In many *weakly* subjects, on the other hand, we constantly observe

increased energy of all functions, better appetite, and greater ease of muscular action—probably because their organism is less taxed, the loss of heat being diminished and the action of the skin increased. Weakly persons, therefore, and such as have been temporarily enfeebled, do very well in moderately warm climates.

Influence of low temperatures.

Diminished temperature of the air causes increased loss of heat from the organism, owing to the skin coming in contact with the colder air and the latter being respired. In *healthy* subjects and in various cases of impaired health without organic disease, such as fulness of veins, torpor of the abdominal organs, sluggishness of tissue change, and hypochondriasis, we observe increase of tissue change, of respiration, circulation, appetite, and sanguification, and also greater vigour in all the functions of the nervous and muscular systems. In *weakly* persons, on the other hand, some of these functions, or, to a certain extent, all of them, are disturbed. Thus there are delicate subjects who in cold climates, and even in comparatively warm climates, when the temperature gets low in winter, experience loss of appetite and complete arrest of the intestinal movements: there are others in whom the nails degenerate; others who become slightly icteric; again others in whom a form of chlorosis develops itself in the course of 6 or 8 weeks, accompanied by cessation of the menses; others in whom catarrhal affections of the mucous membranes are always present, the mucus being sometimes tinged with blood: in two cases under our own observation exposure to cold climates, or even the cold season of temperate climates, produces a tendency to hæmaturia, which can be removed only by passing to warmer climates, but this invariably succeeds. In recommending climatic resorts we must bear in mind that age is of great moment as regards the effects of low temperatures; and that whereas in children, excepting mere infants, and in adults under 60 the mortality is scarcely increased, in elderly people the increase is considerable. Thus we see from the report of the Registrar-General on the mortality in England for the last quarter of the year 1878, the temperature having been rather low in November and December, that in persons above 60 the mortality was higher by 24 per cent.

than in the corresponding and mild last quarter of 1877, whilst the increase among persons below 60 was only 8 per cent. This is a common experience, and the periodical publications of the Imperial German Board of Health furnish a great deal of evidence in the same direction.

When considering the influence of high temperatures we found a difficulty in distinguishing between the effects of the temperature *per se* and those of other associated causes, and this applies also to the effects of low temperatures. Under a clear sky and in calm and dry air very low temperatures, such as 10° or even 5° F., are borne more easily than a moderately low temperature (above 32° F.), if the air is at the same time very damp and the wind high; for, as will readily be understood, both these conditions, and particularly the latter, increase the loss of heat disproportionately and even several times over. In countries where the air is moist and windy weather prevails, such as the British Isles, we observe that in cold weather the mortality among elderly persons is invariably increased, though the temperature is very little below the freezing point or even slightly above it. Hence the inhabitants of such countries cannot easily understand that in elevated places with a dry and still atmosphere, such as the Engadine, Davos, and other valleys of the High Alps, temperatures of 10° or even 5° F. are endurable without great discomfort, a point to which reference will be made later on in considering the climates of high altitudes. In other cases the comparatively slight cold is perhaps but the seeming cause of the increased mortality. Frankland, for instance, lately made an important communication to the Royal Society on the subject of 'Dry Fog,' showing that in great industrial centres during the prevalence of certain fogs the air is saturated with the products of incomplete combustion of coal-tar and paraffin, thus irritating the respiratory organs most violently, and probably also affecting tissue change.

In judging of the effects produced by cold or heat, we are inclined to be prejudiced by the sensation we experience of comfort or discomfort. Hence many people associate the notion of '*cold*' with an *injurious effect* on health. It would be quite fallacious to draw such a conclusion, and in proof we

may quote the experience that the death rate decreases to a certain extent with the distance from the equator. Thus Michel Lévy gives the following table in his 'Hygiene:'—

From the—

Equator	to the	20th	degree of latitude,	1 case	of	death	to 25	inhabitants.
20th	„	40th	„	„	„	„	35·5	„
40th	„	60th	„	„	„	„	43·2	„
60th	„	80th	„	„	„	„	50·0	„

For France alone Lévy quotes, according to Adolphe Motard, the following calculation, based on a division of the whole of France into a northern and southern half, the Loire forming the approximate frontier between the two:—

Northern half:	births, 1 in 35·57;	deaths, 1 in 43·44
Southern half:	„ 1 in 33·40;	„ 1 in 40·00

III. *THE MOISTURE OF THE ATMOSPHERE.*

Capacity of the air for moisture.

Aqueous vapour is one of the normal constituents of the atmosphere; the quantity which the air can contain, its capacity, is proportionate to the temperature, with which it rises and falls and concerning which detailed tabular statements are accessible.

Absolute and relative humidity.

The quantity of vapour contained in a given volume of air is called its *absolute humidity*; the ratio between the amount of humidity actually contained in a given volume of air, and the largest quantity which it could possibly contain—that is, its capacity or complete saturation—is called *relative humidity*. By *dry* air we understand a low degree of relative humidity, and by *moist* air one which is near the point of saturation. The lowest degree of humidity observed by Humboldt was 23 per cent., saturation being 100, but yet lower degrees do occur. We call air very dry if it contains less than 55 per cent. of moisture, moderately dry if between 55 and 75 per cent., moderately moist between 75 and 90 per cent., very moist between 91 and 100 per cent. The relative humidity, however, should always be considered together with the temperature, for only in conjunction with this can it be properly estimated.

The absolute humidity of the air is also called *vapour pressure*; it can be measured by a column of mercury, and is included in the barometrical reading, from which it must be subtracted in order to obtain the pressure of the dry air alone. Air which is saturated at a temperature of 32° F. has a vapour pressure of 0·177 inch, at 54·5° of 0·422, and at 77° of 0·923 inch. But air is only rarely saturated, and, as warmed air takes up more moisture than cold air, the periodical variations of vapour pressure in the course of the year exhibit a striking concordance with those of temperature—that is, they are lower in winter and higher in summer. Thus in Vienna the vapour pressure for January is 0·138 inch, for April 0·215, June 0·415, August 0·437, October 0·301, December 0·141; annual average, 0·269; range, 0·296. In Rome for January 0·242 inch, April 0·293, July 0·552, October 0·409, December 0·342; annual average, 0·376; range, 0·309. Exceptions may, however, occur, as in other meteorological conditions.

Variations of absolute humidity (of vapour pressure).

As the vapour pressure increases with temperature it is considerably higher in tropical regions than in moderate and high latitudes. Thus for Madras the mean annual is 0·959 inch, being in January, when the pressure is lowest, 0·815, in September, when it is highest, 1·062, the variations amounting to 0·247; in St. Petersburg the mean annual is as low as 0·255. As regards elevated regions, we may say that the vapour pressure decreases as we ascend, but this general rule is modified by local conditions, to which we will refer later on. Sea climates or oceanic regions present lower annual variations than continental places. Thus in St. Helena, with a mean annual of 0·528 inch, the variations are only 0·167 (Lorenz and Rothe).

The daily range of vapour pressure is subject to greater variations in summer than in winter, and to greater ones in continental than in oceanic climates. Generally speaking, it rises and falls with the temperature; but about noon and for some hours afterwards, when the warmed air rises and carries with it the aqueous vapour contained in it, the evaporation of moisture cannot keep pace with the rise in temperature. This is much more noticeable

Daily range of vapour pressure.

in summer than in winter, so that in the former there are two maxima and two minima, the first maximum being reached several hours after sunrise by the abundant evaporation, while the first minimum takes place between the hours of 2 and 4 P.M. Then, owing to a decrease in the ascending air current, the proportion of vapour increases and a second maximum is reached between 7 and 10 P.M., to be followed by a second minimum towards sunrise, in consequence of a decrease taking place in the absolute humidity by the fall of temperature and the condensation of aqueous vapour (N. Graeger).

The range of the *relative humidity* is almost the opposite of the preceding. Since air rising in temperature requires more humidity for saturation, the proportion of humidity compared with the point of saturation is lower at high temperatures, on account of the increase in humidity not keeping pace with the temperature if the latter rises high. Thus, as regards different seasons, the relative humidity is lower in the summer than in the winter months, generally being lowest in May and June, and highest in December and January. As to the daily periods, the maximum takes place at sunrise and the minimum during the early hours of the afternoon. The differences between the different times of the day are greater in summer than in winter. In winter the variations between maxima and minima, as regards Western Europe, are from 6 to 10 per cent., and in summer from 20 to 28 per cent. According to Dove the relative humidity decreases with increasing elevation above the sea; but it seems that the variations met with in different regions and strata of air are even greater than in the case of the absolute humidity. The variations are less in elevated regions than in lowlands.

Range of the relative humidity.

The character of the prevailing winds, whether moist or dry, has a considerable influence on the moisture of the air.

The dew point is the degree of temperature at which part of the aqueous vapour contained in the air condenses into the liquid state, because the air at such a temperature can no longer contain the whole quantity of aqueous vapour. W. C. Wells, an English physician, was the first to give a thorough explanation regarding the process of the formation of dew.

Dew point.

If aqueous vapour is cooled in the air, and cannot deposit itself on solid bodies, it condenses into minute particles of water or spicules of ice. These particles, when aggregated in larger masses, form fogs or clouds, there being no real difference between the two, for fogs floating high in the air appear as clouds if viewed from below. We cannot here enter into details as regards the formation of fogs and clouds, or the different kinds of clouds. The number of foggy days, however, at a given place, and their distribution over the different times of the year, must be considered in judging of the value of its climate; so also must attention be paid to the period of the day at which the fogs form.

Fogs and clouds.

Another point closely related to the last is the proportion in which the sky is covered with clouds. This is generally expressed in a fractional form, the maximum being taken as 4 (or 10). How far the amount of cloud affects the climate of a place will be easily understood by considering that the influence of the direct sun-rays, and of their illuminating, warming, and chemical effects, is considerably modified by the state of the sky. Thus Fritsch, from observations made at Prague, has stated that the range of temperature on cloudless days is three times that met with in spring and summer on cloudy days, whilst in autumn and winter it is only twice. For our purpose it is of importance to know, as regards a given health resort, how far the sky is covered at different seasons and in different months and times of the day. The amount of cloud depends on various conditions, and especially on the situation of a place; it is generally greater on coasts and islands than in the interior of continents. The elevation above the level of the sea is an important factor. Thus in ascending mountains we pass through fogs and screens of cloud, but at a certain height, varying according to the situation of the mountains and with the seasons, we arrive at comparatively cloudless regions, in which the sky is clear for days and weeks. It is therefore necessary to know whether a place lies above, within, or below the ordinary region of clouds, and to what extent the different seasons influence these conditions. The direction of the prevailing winds is also closely related to the amount of cloud. In the west of Europe the west and

Amount of cloud.

north-west winds are mostly accompanied by a cloudy sky, and the east and north-east winds by a clear sky.

Rain.

Clouds are precipitated in the form of rain or snow either by cold or by concussion and compression. Warmth, on the other hand, tends to dissolve clouds, as may be constantly seen in mountainous regions. The conditions of rainfall are closely related to the winds, and more particularly to their temperature, moisture, electrical state, and velocity.

The quantity of rain which falls at different places differs greatly: of rainless regions, the Sahara, in Africa, and the desert of Gobi, in Asia, are examples; there is almost complete absence of rain over large areas of the west coast of Peru and Chili, on the east coast of Patagonia, and in other regions; whilst on the south-eastern declivities of the Himalayas, owing to the hot monsoons saturated with moisture, the annual rainfall is swelled to 590 inches. The circumstances which determine the amount of rainfall of a region are partly *general*, such as latitude and elevation above sea-level; and partly *local*, such as the vicinity of large sheets of water, exposure to moist winds, and proximity of mountains. The latter, by retaining the moisture and precipitating it, cause an increase in the amount of rain on one side of them, while the other is comparatively rainless. As regards the distribution of rain according to parallels of latitude, we may say in a general way that the average fall diminishes as we recede from the tropics; this rule, however, is subject to many exceptions, as instanced, on the one hand, by the Sahara and the coast of Peru having a small amount of rain, and on the other by Bergen, in lat. 60° N., with an annual rainfall of about 89 inches. Absence of rain does not at all go hand in hand with a low degree of moisture in the air, for a region may have a very moist atmosphere and yet be rainless if it is free from cold currents of air which condense its moisture. Thus, though the air of Lima, on the coast of Peru, is generally very moist, it hardly ever rains there; and, conversely, regions with much rain may be moderately dry as regards air and soil, such as the Gulf of Genoa.

As regards *height above the sea*, it is generally held (Gasparin and others) that the amount of precipitation increases with the height. The results obtained from the Swiss hydro-

metric stations, as collected by Chaix ('Le Globe,' 1873), are on the whole in keeping with this principle. They give an annual rainfall varying from 36 to 40 inches for the low districts of Switzerland, and of 48 to 71 inches for the more elevated regions, excepting certain valleys protected by their direction from rain-bearing winds; for instance, the Engadine, which has a total rainfall of but 31 inches, owing to its north-easterly direction and its protection from west and north winds. This rule, however, does not in the least apply to America, where almost the opposite obtains, though exceptions take place, partly due to local conditions.

It may be accepted as a general rule, at least for Western Europe, that the amount of rain is greatest near to the sea, and that it diminishes with the distance from the same. Thus it is greater on the west coasts of Great Britain and Ireland than in their interior, greater on the west coast of France than in its middle and eastern portions, and greater in St. Petersburg than in the interior of Russia. The number of *rainy days* does not always coincide with the amount of rain, for at some places it rains comparatively seldom, whilst the quantity which falls in a few hours equals the amount supplied at other places during a series of rainy days. These conditions are of importance for climatic treatment, as on them depends the time that may be spent in the open air, and the state of the sky and soil; moreover, the hygrometric conditions are closely related to them. Generally speaking, and subject to many exceptions, the number of rainy days increases from the tropics towards the poles, whilst the amount of rain decreases; thus, as regards the northern hemisphere, the approximate annual average is 78 rainy days for the zone comprised between lat. 12° and 43°, 103 days between 44° and 46°, 134 days between 47° and 50°, and 160 or even 178 days between 51° and 60°. The rainy days seem to increase in number with the height above the sea up to moderate elevations, and they decrease again as we ascend farther. In the region of calms, it rains almost daily. Here the sun mostly rises in a clear sky; but about midday clouds gather, which in the afternoon pour down prodigious quantities of rain. Towards evening the sky clears up again, and remains clear during the night.

Respecting the distribution of rain over the different times of the year in Europe, autumn rains prevail in Ireland, England, Southern and Western France, Italy, Greece, and Norway, whilst summer rains are more frequent in Germany, Denmark, and Sweden. Spring is the dryest time of the year in England, the west coast of Europe, and also in Scandinavia and Russia; while summer is the comparatively rainless time in the south of France, south of Italy, and especially in Spain and Portugal, the winter being the chief rainy season in both the latter countries. As to the Alps, Messrs. Schlagintweit pointed out a great difference according to different districts; autumn rains prevailing in the southern and western parts; summer rains, on the other hand, in the northern. In the western parts the amount of rain is less in summer, whilst in the northern it is less in winter. The annual rainfall on the southern slopes of the Alps is given as 57·5 inches, on the western slopes as 47, and on the northern as 36·3 inches.

Rain as a factor of climate.

Many authors on climate have considered much rain, and more especially the frequency of rainy days, as drawbacks to health resorts; but these factors may be looked at from a different point of view. Unless rain falls so frequently or continuously as to prevent invalids from spending sufficient time in the open air, it has the great advantage of clearing the air from organic and inorganic impurities, and probably also of rendering it more invigorating by favouring the formation of ozone and by diminishing the relative humidity. At any rate it is a common experience with many people that they feel fresher and more fit for work during and after rain. Walking exercise, too, in rainy weather seldom does harm if proper care be used; in many cases it is even preferable to walking under a broiling sun or in a sultry and rainless atmosphere.

Snow.

Snow, or crystallised rain, depends on low temperatures, and the fact of snow remaining on the ground indicates that the latter has been cooled for a longer or shorter period. There are, of course, vast regions where snow never falls at sea-level or at moderate elevations (generally speaking, between the parallels of 36° N. and 30° S.); whereas in districts having cold winters, and also on high mountains,

much more snow falls than rain. The temperature of the air determines also in a great measure the height of what we call the snow line, above which the snow never melts. This line of perpetual snow varies according to the influence of different conditions; generally speaking, it sinks from the equator towards the poles, but it is higher on the south than on the north side of mountains, and it falls in districts where much moisture is precipitated from the air; it also varies according to the shape and grouping of mountains.

Snow as a factor of climate.

It is a common belief that snow is hurtful to invalids, but this is as much a fallacy as the supposition that climates with an abundant rainfall are necessarily unhealthy; the other climatic conditions and the nature of the soil are the deciding factors. It must be admitted that the frequent melting of the snow has an injurious effect, catarrhs of different kinds being thereby favoured; but if the snow remains on the ground for several months important advantages result. Thus the heating of the ground by the sun and the resulting air currents and winds are almost entirely avoided; the air is less impregnated with vapour and is diathermanous for the sun's rays, so that the illuminating, chemical, and warming power of the sun is much augmented; and, finally, the snow covering the ground not only prevents ordinary dust from accumulating in the air, but also the rise of emanations from the soil, which being mixed with organic ingredients favour the formation of spores. This subject could be worked out in many ways, and might go far to explain the effects of certain climates in the treatment of chronic affections of the respiratory organs. Indirectly also a climate is influenced by the ground being covered with snow, because snow is a bad conductor of heat and serves to protect the soil in winter in two ways: (1) it prevents radiation; and (2) it sets a limit to the depth to which severe frosts penetrate, thus protecting many plants and influencing vegetation remarkably, as is shown by the luxuriant way in which Alpine roses thrive on the Alps at a height of between 4,000 and 7,000 feet above the sea, whilst they perish on plains and in low valleys.

Connected with the moisture of the air there is another element of climate—viz. the drying or evaporating power of the

air of a region, a variable quality, which depends on the temperature, relative humidity, and density of the atmosphere, and its amount of movement. The rate of evaporation is high when the air is warm and dry, and it is increased by winds; it is low, on the other hand, when the air is near saturation point and when it is calm; but it may become fairly rapid, owing to strong winds, even if the air be near saturation. Hence the rate is highest in summer under the influence of the sun's rays and of air currents, but comparatively low in winter, in the shade, and when the air is calm; at noon and during the first hours of the afternoon evaporation is greater than in the morning, evening, or by night; in settled rainy weather, and during fogs with a calm air, it is entirely or almost entirely wanting.

Evaporating power.

Owing to the drying power of the air, or, so to speak, its thirstiness, the atmosphere is continually provided with moisture, which is just as necessary for organic life on the earth's surface as oxygen, warmth, and the solid ingredients. The moisture of the air regulates the distribution of temperature; it takes up part of the direct heat from the sun, and, yet more, part of the heat radiated from the earth. The heat thus taken up is carried by air currents into higher regions and to great distances. The moisture of the air not only moderates evaporation from the soil, but also the force of the sun's direct rays, both of the heat rays and those of light, thus producing a greater equability of climate. The moisture of the air is the medium for the formation of dew, rain, and snow, and is closely connected with the formation of ozone and with the electrical conditions. Whilst in dry climates and in dry seasons the differences between sun and shade and between day and night are very great, the opposite obtains in wet months. On the other hand, the presence of large quantities of moisture may restrict the access of the sun's rays to the earth for days and weeks, and a climate may, consequently, become less enjoyable and somewhat depressing. Even the little we have already said will show sufficiently that a consideration of the conditions of moisture is most important for the knowledge of the physiological and therapeutic effects of a climate.

The moisture of the atmosphere as a factor of climate.

Physiological and pathological effects of the moisture of the air.

Nothing very definite, however, can be said regarding the *physiological and pathological effects* of the moisture of the air, because their influence cannot be separated from those of the temperature, the pressure, and movement of the air. The amount of *absolute humidity* is important for pulmonary respiration, the inspired air being not only heated in the lungs, but being also saturated with moisture, so that the quantity of moisture given off in respiration differs according to the amount of moisture contained in the air. As cold air contains but little moisture, the quantity of moisture exhaled from the lungs will be greater in cold than in warm air. The *relative humidity* must, of course, likewise be considered, as dry air can take up more moisture than damp air of the same temperature. The secretion from the mucous membranes of the respiratory organs is frequently diminished by a residence in a dry climate, and we frequently have recourse to this agent in treating chronic catarrhal and ulcerative states. The air being raised in temperature, and evaporation taking place, heat is also often given off, the quantity of which is greater in cold and dry than in warm and moist air. The *relative* humidity has a particular relation to the skin, which, according to the degree of saturation of the air and its movement, yields up to it more or less moisture, and, owing to evaporation, more or less heat. If the air is moist it is a better conductor of heat, but diminishes evaporation, the amount of wind being the same. By these conditions the skin is influenced in different ways. When the air is dry, the evaporation from the skin is increased according to the amount of movement in the air, and with evaporation a corresponding quantity of heat is lost. As a consequence heat is much more easily borne in hot weather, when the air is dry, than when it is moist, and more especially so if there is a wind blowing at the same time. In cold weather, when the air is dry, heat is also lost by evaporation; but this loss is not great, and may be much limited by clothing, unless there is a good deal of wind. When, on the other hand, the air is moist, the loss of heat by *conduction* is much greater than in dry air, and is considerably increased by winds. Hence, when thaw sets in, the moist air frequently feels much colder, though it may be

by 20° or 25° F. warmer than during the preceding frost, when it had been dry. This may partly account for the frequency of catarrhs when it is thawing and when the snow melts, though a still greater share in producing it must be attributed to the fact that the formation of germs is promoted in moist and comparatively warm air. Generally speaking, dry air is more bracing than moist air, and high temperatures, as mentioned above, are more easily borne in a dry than in a moist atmosphere; but dry air combined with very low temperatures irritates the respiratory organs and produces in them a tendency to inflammatory affections, particularly to pneumonia; whilst moist air combined with cold predisposes to catarrhs and bronchitis, and also to rheumatic and gouty affections. On the other hand, moist air combined with warmth exercises a soothing influence on the mucous membranes, and the strain upon the constitution is less; but in persons exposed to it for a longer period the appetite begins to fail, and the functions of the digestive organs and of the nervous system become impaired. Hence there arises a feeling of languor and an inability to withstand injurious influences from without, also a tendency to diarrhœa, which we have not only observed in invalids to whom we had recommended such climates, but also, and even to a marked extent, in healthy subjects who had accompanied the former. When the air is very moist, the proportion of water passing off from the skin and lungs is diminished, and more work has to be done by the kidneys, whilst in a warm and dry air the latter are less tasked—a fact that has always to be borne in mind in the treatment of affections of the kidneys.

We attribute quite as much importance to the circumstance that moisture combined with warmth favours the development of low organisms. Many of the dangers of such climates may be thus accounted for, whilst in a cold and dry atmosphere the growth of such organisms is checked to a great extent.

Dampness of soil, which of course is accompanied by a moist condition of the lower strata of the atmosphere, seems to have a certain relation to the development of rheumatic affections and of phthisis. This is proved by the fact that at many places where a proper system of drainage of soil water was carried

out the mortality from phthisis was considerably diminished (Bowditch, Buchanan, Simon). Here also the low organisms developing more easily in moisture may be the intermediary causes, whilst moisture *per se* does not occasion an increase in phthisis.

A sudden increase of the moisture of the atmosphere seems to produce as considerable modifications in the bodily functions as a sudden increase of temperature. Less moisture being lost by the skin and lungs, more will have to be given off by the kidneys and intestines. Polyuria and diarrhœa are, therefore, of by no means unfrequent occurrence (Stewart, Hirsch, Thomas, Rohden); and if a sufficient quantity of water be not removed in this way, a transitory increase of the liquid constituents of the blood seems likely to result. Rohden ascribes to this circumstance the more frequent occurrence of pulmonary hæmorrhage at times when the moisture of the air is suddenly increased.

IV. *LIGHT.*

Light is closely connected with heat, and the study of its influence on animal bodies, apart from that of heat, has as yet made but little progress. In physics and chemistry the sun's rays are separated into light rays, heat rays, and chemical rays; and it is known that the luminous effect lies chiefly in the orange, yellow, and green rays, the heating effect in the red and the chemical in the blue and violet rays. It is also found that beyond the visible violet rays of the solar spectrum there are invisible rays having a powerful chemical effect, often called 'actinic rays.' It is supposed that the effect of the light rays depends on their intensity and colour, but even the measurement of the intensity of light has not yet been sufficiently worked out. The chemical effect of the direct sunlight, according to Schell, attains its daily maximum at noon; as to monthly periods, it is least in December and January and greatest in July and August; it also diminishes with the distance from the tropics to the poles.

Sunlight is more powerful in rarefied and dry air (on

mountains) than when the atmosphere is full of vapour. Besides direct sunlight, there is also thrown on the earth's surface the light reflected from the clouds, the effects of which are evidently not identical with those of direct sunlight.

With regard to the effect of the light from the moon and stars, our knowledge is even less exact than as to the effects of sunlight.

Action of light on plants.

Respecting the action of light on plants it has been found that the formation of their chlorophyll granules takes place under the influence of light, and that the leaves exhale oxygen chiefly during the daytime. This is owing to the composition of their organic substances, which are poor in oxygen compared with carbon, hydrogen, and nitrogen. Generally speaking, the formation of flowers and fruit goes on more actively in proportion to the amount of sunlight they receive; but in the case of most plants the light must not be too intense, and many cannot bear direct sunlight, completing their growth only in shade, whilst another class is subject to considerable changes according to the degree and nature of the light. In some cases it seems that heat may be substituted partly or wholly for light, but in others heat does not suffice without light. It is a daily experience that leaves turn towards the light if this comes only from a certain direction.

Action of light on man.

As regards the action of light and its constituents on the higher animals, and particularly on man, we know but little, and, as mentioned above, these investigations are rendered very difficult by the fact that the effects of light can hardly be separated from the accompanying conditions of heat, moisture, and the composition of the air. It may, therefore, be of some interest to consider the effects of deficient light. In climates where the sun is either entirely obscured by fogs and clouds for weeks and months together, or is only rarely shining with full light, but more often as through a thick veil, medical men have frequently occasion to observe, in new arrivals, depression of spirits and failure of mental energy; also loss of appetite, gastric disturbance, turbid urine, and a kind of home sickness. These symptoms persist in some people for years in a varying degree, according to the weather and the occupation; a few of the patients will never acclimatise.

We are frequently reminded of a verse of poetry by Geibel, in which 'the gipsy lad in the North' laments as follows:—

Dieser Nebel drückt mich nieder,
Der die Sonne mir entfernt,
Und die alten lust'gen Lieder
Hab' ich alle fast verlernt.[1]

These symptoms of home sickness being more bodily than mental, are met with in London not only among gipsy lads, but also among Savoyards exhibiting marmots, street musicians from the Haardt Mountains, watchmakers from the Black Forest, and frequently among the Swiss. It must be obvious to the medical observer that these complaints are largely due to the want of sunlight, particularly if, as is frequently seen, two or three weeks of clear weather relieve all the symptoms, or make them disappear, whereas they return in dark weather, and vary sometimes according to the degree of clearness or dulness of the sky.

We have met with several cases of intermittent fever of an irregular type occurring in servants kept in large mansions, who were living in rooms half underground, and having only small windows, so that direct sunlight could never reach the rooms, and altogether but little daylight. The attacks of fever for which a malarious origin could not be proved gave way to large doses of quinine, though more slowly than ordinary cases of mild ague; and in one case they returned three times, in each instance several weeks after the servant had returned with the family from the country to town. After the windows of the room had been enlarged, so that at least a small quantity of direct, and much reflected, sunlight could penetrate into it, no further relapses took place. In one of the cases a pronounced enlargement of the spleen had developed during the attacks, having been absent before. A similar experience was made in a London hospital on two patients who were laid up for months in a rather dark room on account of surgical affections. In these cases too the

[1] 'This fog how it oppresseth me,
And it keeps the sun afar;
The old and joyous songs can never be,
As they all forgotten are.'

attacks disappeared after quinine had been given, and similar cases were not observed after the room had been improved.

Effect of light upon bacteria.

By the interesting investigations of Downes and Blunt on the 'Effect of Light upon Bacteria and other Organisms' and on the 'Influence of Light upon Protoplasm' ('Proceedings of the Royal Soc.,' vols. xxvi. and xxviii., 1877 and 1878) some clue to the nature of these and similar conditions was furnished. The experiments of these authors on the behaviour of Pasteur's solution, of urine, and infusions of hay, when exposed to or excluded from light, gave the following results: that light is inimical to the development of bacteria and the microscopic fungi associated with putrefaction and decay; that the preservative quality of light is most powerful in the direct solar ray, but can be demonstrated to exist in ordinary diffused daylight; that germs originally present in such a liquid may be wholly destroyed by sunlight, and that the actinic rays of the spectrum seem to have the greatest effect. Downes and Blunt are led to the conclusion that the effect of light and of oxygen is a gradual oxidation of the constituent protoplasm of these organisms, and that, in this respect, protoplasm, although living, is not exempt from laws which appear to govern the relations of light and oxygen to forms of matter less highly endowed.

From these results it seems not unlikely that oxidation is less complete when light is deficient, either in the open air or in dark rooms, than when light has free access; that germs and other low organisms develop more easily in places from which light is excluded; and, further, that perhaps even in the higher animal organisms, when deprived of light, oxidation does not take place so energetically, and that tissue change and nutrition are impaired, whilst a moderately increased amount of light probably accelerates tissue change.[1] Former investigations by Moleschott on batrachians also support this view, showing that these animals, under the same conditions of temperature, exhale more carbonic acid when exposed to light

[1] According to a communication by Tyndall (*Proc. Royal Soc.*, vol. xxviii. 1878) which came to our notice since this article was written, it seems that the results obtained by Downes and Blunt are not invariably due to the effect of light.

than when excluded from it, and that the quantity of carbonic acid rises with the intensity of light. At a still earlier date W. F. Edwards, from experiments on frogs, was led to the conclusion that the influence of light is necessary for the development of the proportions of the body as characterising the type of species. Recently Jubini has shown that, even after removal of the lungs, batrachians exhale more carbonic acid under the influence of light than when light is excluded.

Duration of insolation.

In considering the influence of light at different places, it is of importance to know how long the possible insolation of a place lasts in different seasons. It is obvious that in higher latitudes insolation lasts longer in summer than at places nearer to the equator, but that in winter the opposite condition obtains, and that, for instance, in the middle or south of Italy an invalid can in winter enjoy the sun and daylight for several hours longer than in northern latitudes (in lat. 54° or 55°). This point must also be considered in Alpine valleys, where the mountains exclude the sun for part of the day.

V. *THE WEIGHT OR PRESSURE OF THE ATMOSPHERE.*

The air pressure.

It is well known that the pressure of the whole atmosphere at the sea level is equal to that of a column of mercury of about 30 inches, and that the weight of the air varies (1) according to latitude, (2) according to the elevation of a place above sea level, and (3) according to the times of the day and year and to other influences.

Variations according to latitude.

1. The mean pressure in the equatorial regions is about 29·843 inches, being particularly low, owing to the expansion of the air by heat, the rising of the lighter air, and its flowing off in the upper regions towards the poles. It increases with the latitude, and is highest between the parallels of 30° and 40°, about 30 to 30·079 inches. This increase seems to be due to the existence of two currents of air lying one over the other, an under one flowing from higher latitudes towards the equator, and an upper one from the equator towards higher latitudes. Farther towards the poles

the pressure is again diminished, and is lowest between the parallels of 60° and 70° (Müller). Thus it is only 29·607 in Reykjavik (Iceland: lat. 64° 8′ N., long. 21° 55′ W.), whilst in Spitzbergen (lat. 76° to 80° N., long. 9° to 22° E.) it amounts to 29·764 inches. The decrease is, however, not at all uniform.

Variations according to altitude.

2. As we rise above the level of the sea the pressure of the air decreases, because the weight of the column of air above an elevated place must be diminished just in proportion to the weight of a vertical column of air extending from the level of the place in question to the sea level. We have tables showing the exact proportion of the decrease, and we can therefore determine heights by the amount of air pressure, provided the necessary correction for temperature be made. The lower strata of the atmosphere are much heavier than the higher; thus a layer 34·6 feet high, at a pressure of 29·922 inches, has the same weight as a layer 55 feet high (at Potosi) at a pressure of 18·544 inches, and at an elevation of 15,980 feet above the sea; or, in other words, the air is denser by more than one-half at the sea than at the height of Potosi. At Potosi one has to rise 55 feet for the barometer to fall 0·039 inch, whilst at the sea shore one has to rise only 34·6 feet.

Periodical variations of atmospheric pressure.

3. The variations of barometrical pressure at any given place are partly periodical, partly non-periodical or accidental. Of *periodical* variations we notice—(*a*) the *daily range*, showing two maxima and two minima. Commencing at noon, we find as a general rule for the northern hemisphere—

a fall to the 1st minimum from 3 to 5 P.M.
a rise to the 1st maximum from 9 to 11 P.M.
a fall to the 2nd minimum from 3 to 5 A.M.
a rise to the 2nd maximum from 9 to 11 A.M.

The range is greater in the tropics than in the temperate and moderately cold zones; thus it is at Cumana (Venezuela: lat. 10° 27′ N., long. 64° 11′ W.) 0·093 inch, at Paris (lat. 48° 50′ N., long. 2° 20′ E.) 0·0305 inch, and at St. Petersburg (lat. 59° 56′ N., long. 30° 19′ E.) 0·0078 inch. It is greater in summer than in winter; thus the daily range at Milan in summer is about 0·0378, whilst in winter it is only

0·0273, and at Halle, in Germany, it is in summer 0·0224, in winter 0·0142.

(*b*) *Annual range.* Speaking generally, the atmospheric pressure is greater in winter than in summer, and this difference is greater, and at the same time more regular, in the tropics than in higher latitudes. At Calcutta (lat. 22° 33′ N., long. 88° 19′ E.) the pressure is highest in January, decreasing until July (29·43 inches), and thence again rising until January (30·101 inches), thus showing an annual range of 0·671 inch. At Macao, in China (lat. 22° 10′ N., long. 113° 32′ E.), the maximum in December is 30·262 inches, and the minimum in June 29·816, the difference being 0·445 inch. At Berlin (lat. 52° 30′ N., long. 13° 23′ E.) the maximum in December is 29·996 inches, and the minimum in June 29·816, the difference being 0·180 (the increase from the minimum to the maximum is not marked by any decided regularity). At St. Petersburg (lat. 59° 56′ N., long. 30° 19′ E.) the maximum in January is 29·922 inches, and the minimum in July 29·785, the difference being 0·137 inch.

Influence of heights on the periodical variations.

The periodical variations are less on heights, owing to the column of air above any elevated place being shorter. Thus Kaemtz gives the daily fluctuations at Zürich as 0·0624 inch, and on the Faulhorn as only 0·042. Further, the curve of diurnal variation of the barometer on the Faulhorn differs from that in the valley. On the former the barometer falls from noon until about 5 A.M., and then rises until about noon, thus showing only one maximum at about noon and one minimum at 5 A.M., whilst in the valley two maxima and two minima occur, as has been pointed out above. The observations of Kaemtz, Martins, and Plantamour show that the non-periodical variations are also less on heights.

Non-periodical variations.

The non-periodical variations are much more considerable than the periodical. They are greater in the colder months than in the warmer, and greater in higher latitudes than near the tropics. Thus the variations between the mean monthly maximum and minimum are at Batavia (lat. 6° 12′ S.) 0·0117 inch, at Havannah (lat. 23° 9′ N.) 0·0250, at Berlin (lat. 52° 30′ N.) 0·100, at London (lat. 51° 31′ N.) 0·1092, and at Christiania (lat. 59° 55′ N.) 0·130 inch.

Charts have been published laying down the *isobarometric lines*, or lines connecting the places where the barometric readings give the same mean monthly fluctuation. The term *isobaric lines*, on the other hand, has been applied to lines showing an equal mean atmospheric pressure at different places for the year (annual isobars) and for the different months (monthly isobars). These isobaric lines are of the greatest importance for meteorological purposes, as they enable us to determine the prevailing winds and the climatic conditions depending on them.

Causes of barometric variations.

The principal cause of the barometric fluctuations is the unequal and continually varying distribution of temperature; and in connection with it there is a second cause—the varying amount of moisture of the air. Air being heated becomes lighter, rises upwards, and escapes to higher levels; the pressure of a heated column of air must, therefore, be less, whilst a colder column of air of the same height must be heavier. Movements of the air may at one time cause currents of different temperature to lie over one another, and at another time may lead to their dislodgement, thus causing continual fluctuations. Of the sum total of the atmospheric pressure a small part is not produced by the air (N and O) itself, but by the aqueous vapour contained in it. When part of the latter condenses—that is, when it takes the form of minute vesicles, or is precipitated by rain or dew—the column of air loses in weight in proportion. The winds exercise a considerable influence on the atmospheric pressure, according to their temperature and amount of moisture.

Physiological effects.

The physiological effects on the human organism of the ordinary periodical and non-periodical fluctuations of barometric pressure, though evidently of importance, cannot easily be defined, owing to their being constantly combined with variations of other elements (warmth, moisture, electricity, &c.) Some light may, however, be thrown on this subject by the consideration of the effects due to greater variations of atmospheric pressure.

Effects of compressed air.

Thus we can avail ourselves of the observations on the effects of compressed air in the air bath, as ascertained by Vivenot, Lange, Panum, and G. von

Liebig. When the pressure is increased by from half an atmosphere to two atmospheres, the principal effects seem to be increase of vital capacity of the lungs, diminished frequency of respiration and of the pulse, the latter gaining in strength at the same time, increased absorption of oxygen and excretion of carbonic acid, and also increase in appetite.

Effects of rarefied air.

The observations on the effects of rarefied air having mostly been made in balloons and during the ascents of high mountains, cannot be entirely separated from the effects of accompanying influences, especially of variations of temperature, of moisture, light, electricity, and ozone; and in mountain ascents the effect of exertion is frequently added as a disturbing element.

As regards the effect of *moderate rarefaction*, I have notes of 28 instances in which Alpine tours were made without exertion—that is, making use of sedan chairs and carriages. Two of the travellers were healthy and vigorous, 21 were healthy but not thoroughly robust, 5 were suffering from chronic disease of the heart or lungs. The ascents took place partly from the sea level to a height of 3,500 feet, partly from places 1,500 to 2,000 feet above the sea to 7,000, 10,000, and 11,000 feet. During the ascents from the sea level to 3,500 feet, or from low-lying valleys to an elevation of 5,000 feet, all the travellers felt very well; their spirits rose, and their appetite increased, and 10 out of 14 felt more thirsty; a moderate acceleration of the pulse by 4 to 10 per cent. took place; and in 9 out of 12 the frequency of respiration rose by 3 to 4 per cent.; all of them, even the invalids suffering from disease of the heart or lungs, could execute easy movements without discomfort and with the sensation of increased elasticity and force. When rising higher, as far as 8,500 feet, the conditions remained the same, even with the invalids, as long as they kept at rest; slight movements, however, produced in all of the subjects a decided increase of the frequency of pulse and respiration, which became considerable in those not used to the mountain air, and was in some instances as high as 80 or 90 per cent. In one of the patients, suffering from extreme mitral regurgitation, these symptoms were accompanied by vertigo and nausea, evidently

arising from cerebral anæmia. In some of the subjects, who were used to mountain climates, the muscular energy was even at this height augmented, and movements seemed to be easier. Even an ascent as high as 10,000 feet, which was undertaken by a consumptive invalid and one suffering from aortic regurgitation, also by five moderately healthy subjects and one thoroughly robust individual, did not cause discomfort as long as they kept quiet, although the frequency of pulse was increased by 8 to 25 per cent.; however, as soon as they began to walk uphill, both invalids (the one with heart disease and the other with pulmonary affection) were attacked by considerable dyspnœa. The former even passed into a fainting condition, the radial pulse becoming almost imperceptible and the heart's action very irregular, which symptoms disappeared after a few minutes, owing to rest and the administration of wine, with the exception of nausea and sickness, increased peristalsis of the intestines, and tenesmus. These symptoms passed off only after the patient had been carried down to an elevation of 8,000 feet.

In the case of the consumptive invalid, the frequency of pulse was increased by 20 per cent. while resting, and by 65 per cent. while walking gently uphill, in the latter case with irregularity of the rhythm; the symptoms of mountain sickness, however, as observed in the invalid with aortic disease, were wanting. After a rest of one or two hours the comparatively healthy subjects could walk a short distance uphill without being so much affected, as regards the action of the heart and lungs, as previously, they having evidently become used to the elevation. Of three moderately strong subjects and one thoroughly robust individual who ascended as high as 10,800 feet, one of the former exhibited a slight increase in the number of pulsations and respirations (10 to 15 per cent.); on moderate exercise there was an increase to 20 or 25 per cent., accompanied by great cheerfulness, increase of appetite, and thirst, and great ease of movements; whereas the apparently vigorous subject, even when kept at rest, had a pulse 20 per cent. more frequent, and when he ascended only slightly it rose 85 per cent., the number of respirations being increased 25 to 30 per cent.; he became, at the same time, exhausted and was

attacked by nausea, vomiting, and diarrhœa. In both the other subjects the number of pulse and respirations rose moderately, and slight fatigue with loss of breath took place when they began to walk uphill. After a short rest these symptoms disappeared, and did not return to the same extent when moderate exercise was taken afterwards.

Hæmorrhage and variations of the bodily temperature during ascents.

Bleeding from the mucous membranes did not take place in any of the cases, and the bodily temperature did not sink more than 0·7° F. and 1·1° F. in the case of both the sufferers from mountain sickness, returning to the normal rate as soon as this condition disappeared—that is, after several hours. All the subjects perspired comparatively little at an elevation of 3,500 feet.

If we make a summary of these symptoms, we find that at moderate elevations, ranging between 3,500 and 5,000 feet, the comparatively healthy exhibited, on the whole, only some increase in the rate of pulse and respiration, accompanied by a sensation of comfort and of ease in movements, also by increase of appetite and thirst and diminished perspiration. On the other hand, at greater elevations, ranging between 10,000 and 11,000 feet, the rate of pulse and respiration is increased in many, and on slight muscular exertion the heart's action in some of the subjects becomes irregular and extremely weak; fainting and symptoms of mountain sickness take place, probably produced by cerebral anæmia, and remedied by stimulants and rest in a horizontal position. In a considerable number of moderately strong individuals the brain seems to become much more active at elevations above 5,000 feet, and in rare cases this activity is rather alarming; allied to it is the frequent occurrence of sleeplessness in a greater or less degree. We have to bear in mind, however, that on mountains most persons can do with a smaller amount of sleep than in plains or on the sea.

Another point frequently noticed in higher altitudes is that alcoholic beverages are much better tolerated. This may be owing to the increased drying power peculiar to rarefied air. In some persons, however, alcohol seems to act more strongly in elevated places, so that Solly accepts this as the rule for Colorado.

The experiences of aeronauts have been described, among others, by Gay-Lussac and Glaisher. The latter experienced on himself, and most of his companions, at an elevation of about 23,000 feet above sea level, increased frequency of pulse, difficulty in breathing, and blueness of the hands and face; at a height of above 26,000 feet more or less inability to move the limbs, and on ascending to still higher regions, loss of consciousness. He never in any of the cases observed bleeding or noises in the ears, and all the symptoms disappeared quickly when the balloon sank, so that Glaisher was able to walk eight miles directly after he reached the ground ('British Medical Journal,' 1862, vol. ii.) Crocé-Spinelli, Sivel, and other French aeronauts of the present time, remained free from any bleeding even at an elevation of 24,000 feet. During the latest more important ascents (which proved fatal to Crocé-Spinelli and Sivel), the height of 26,000 feet was twice surpassed, death being apparently caused by coma and effusion of blood into the air passages.

Balloon ascents.

Here we have to refer to the important observations by Leyden, Lehwess, and others on miners and labourers employed in the building of bridges, who, after working under a pressure increased to two or three atmospheres, return suddenly to the normal pressure. The symptoms frequently observed were pain in the ears and joints, vertigo, and sometimes nausea; in several cases, however, there arose sensory and motor paraplegia, mostly ending in complete recovery after several days, whilst some cases were fatal. In a case where death took place after fourteen days, Leyden found in the dorsal region of the spinal cord that the posterior columns and the posterior portion of the lateral columns contained fissure-like gaps filled with masses of yellowish cells. His explanation is that these fissures arise from rents in the tissue, caused by the sudden setting free of air vesicles (Hoppe-Seyler and P. Bert). We cannot, however, ascribe these to the action of rarefied air, they being simply caused by the sudden transition from considerably increased to normal pressure ('Archiv für Psychiatrie,' vol. ix.)

Pathological conditions owing to sudden or considerable variations of atmospheric pressure.

All currents of air and winds may be regarded as arising from differences of atmospheric pressure, as the heavier air,

being under greater pressure, must, according to the laws of gravitation, move towards a region where the pressure is less; and as the changes in the barometric pressure are caused by variations of the temperature and moisture of the air, we must look upon winds as the result of the difference and change in temperature, moisture, and pressure of the atmosphere. For a more detailed discussion of winds and their laws we refer to the excellent works of Halley, Dove, Mühry, and other authors. In order to understand rightly the different conditions relating to winds, we have constantly to keep in mind the fact that air expands and becomes lighter by being heated, and that it rises to a certain height, whence, owing to gravitation or aspiration, it must flow away in another direction, while heavier air will flow in below to supply its place.

Air currents and winds.

This is well illustrated by the *land and sea breezes*, which are most important from a climatological point of view. In coast districts, some hours after sunrise, the land and the strata of air over it are more heated than the air over the sea; the heated air from the land rises and flows off from higher regions towards the sea, whilst the cooler strata of air over the sea flow towards the land, and thus produce the sea breeze, which, beginning moderately, increases in force until it is strongest during the first hours of the afternoon; it then decreases, being succeeded by a calm about sunset. After sunset the land and the air over it, owing to radiation into space, cool down more quickly than the sea, and the colder and denser air from the land flows towards the sea, giving rise to the land breeze, whilst the air over the sea rises upward and flows off in the opposite direction. Similar phenomena are observed on the large fresh-water lakes of North America, and to a lesser extent on the inland lakes of Europe.

Land and sea breezes.

Other local winds, important in regard to many climatic health resorts, are known as *mountain and valley winds*. In mountainous countries, after sunrise, the bottoms of the valleys and the lower slopes of the mountains become gradually heated, and by them the lower strata of air. The latter, owing to their expansion, rise along the mountain slopes, thus producing the *valley wind*, also called *morning wind*, which at places of higher elevation blows quite regularly during the summer months. After sunset, on the

Mountain and valley winds.

other hand, the summits of the mountains and the higher mountain slopes cool down by radiation more quickly than the lower regions, and the cooler air, or *evening wind*, descends with greater or less velocity along the slopes of the valley towards the lowest parts, which in consequence frequently become colder than the places situated at higher levels. This phenomenon, however, is not confined to the higher mountains, but influences climatic conditions to a great extent even in districts having but slight elevations. We often find that houses built on the top and the slope of hills are warmer in the evening and at night than houses situated at lower levels in the valley, the rule that temperature decreases with increasing height becoming thus reversed, and particular attention has to be paid to this circumstance in the consideration of local climates.

The *Trade Winds*, being of great importance to navigation, attract our attention chiefly in considering sea voyages undertaken for the sake of health. The ascending current produced near the equator by the heating of the earth and of the air in contact with it, after reaching a certain height, flows off towards the poles on either side—*Anti-Trades*—whilst, owing to aspiration, colder and heavier currents proceed from the poles towards the equator—*Trade Winds*. Owing to the rotation of the earth on its axis, the trade wind on the northern hemisphere takes a direction from north-east to south-west, while south of the equator the wind will blow from the south-east to the north-east. The belt in the region of the equator, where these winds meet, is called the *Region of Calms*. The *Return or Anti-Trades* in the upper regions are modified by the rotation of the earth so as to become south-west or north-west winds, according to the hemisphere. At some distance from the equator they descend lower, and in higher latitudes flow often side by side with, and in opposite directions to, the polar currents or trades, and are frequently cooled down by meeting them, part of their moisture being thus precipitated as fog, rain, or snow. The conflict between the opposing currents causes different intermediary winds. The following table, taken from Müller's 'Cosmical Physics,' gives the frequency of the different winds, calculated for different countries per 1,000 days:—

Trade winds and anti-trades.

Countries	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
England . .	82	111	99	81	111	225	171	120
France . .	126	140	84	76	117	192	155	110
Germany . .	84	98	119	87	97	185	198	131
Denmark . .	65	98	100	129	92	198	161	156
Sweden . .	102	104	80	110	128	210	159	106
Russia . .	99	191	81	130	98	143	166	192
North America .	96	116	49	108	123	197	101	210

This table shows that the south-west is the prevailing wind for Western Europe, and more especially for England. As this wind blows over the warm Gulf Stream, it is moderately warm and moist, thus being the cause of a striking feature in the climate of this country, which is shared more or less by the whole of Western Europe.

The direction of winds is to a great extent modified by local influences, especially by mountain ranges, large tracts of water, and forests; and their temperature, moisture, and force are thereby diminished. In the Indian Ocean the trade winds, though considerably modified by the configuration of the surrounding continents, form regularly alternating winds blowing from the south-west from April to September, and from the north-east during the remaining months, and are called *Monsoons*. Heavy showers of rain are a frequent cause of violent winds, the sudden condensation of large quantities of water producing considerable rarefaction of air, so that by aspiration air is attracted from long distances.

In most countries there are winds known under particular names, which are important climatic factors. Though sometimes originating in local conditions, in the majority of cases they arise in distant regions, being merely modified by local conditions.

Simoom. Khamsin. Harmattan.

Thus in Arabia, Persia, and other parts of the East a hot and dry wind coming off the desert is known by the name of *Simoom* (i.e. poisonous wind); in Egypt a similar wind, blowing for about fifty days in spring, is called *Khamsin* (fifty); in Guinea, and in the countries situated to the west of the Sahara and on the west coast of Africa, there is the *Harmattan*, which is felt as far as the Cape Verde Islands.

The *Sirocco* is a hot, southerly, and south-easterly wind from Africa, which blows over Italy and is much feared in Sicily and especially in Palermo. It may be a moist or dry wind at different places and in different times, according to the districts over which it has swept on its passage. A similar wind is the *Solano* of Spain.

Sirocco. Solano.

The *Föhn* of Switzerland has been much under discussion; it is a warm and dry wind, appearing with particular violence in the north-eastern portions of the Alps, chiefly during the latter part of summer, in autumn, winter, and spring. Formerly it was regarded as connected with the Sahara, but the researches of Dove, Mühry, and Dufour have shown that it is a modification of the equatorial current moving from the Atlantic over Europe in a direction from south-west to north-east. This current, though originally warm and moist, loses the greater portion of its moisture by discharging it on the western slopes of the Alps; thus, the author had occasion in the latter part of the summer of 1864, whilst the Föhn was blowing and the sky overcast, to observe a relative moisture of but 30 per cent. together with a temperature of 82° F.

Föhn.

A wind of great importance to the health resorts on the south coast of France and the whole Riviera is the *Mistral* (called 'Maestro' in Italy), a north-westerly wind, blowing from the Rhone valley and Provence, which makes itself frequently and disagreeably felt in the resorts of the Riviera, particularly in February, March, and at the beginning of April. It is a dry and violent wind, being often very cold whilst the sky is clear.

Mistral.

Winds are important factors in climatology, owing to the sudden changes which they frequently cause in the temperature, moisture, and pressure of the atmosphere, and because in a certain sense they carry the climate of one district to another more or less distant. Everywhere they contribute to the purity of the air, and more especially so in hot climates, where they counteract the generation of malaria, as has been shown by Pauly in his excellent work ('Climats et Endémies'); besides, they are important factors of most local climates. We must not content ourselves with information regarding the frequency of easterly, westerly, or southerly

Importance of winds to health resorts.

winds at a given locality, but we must consider the character which winds from certain directions have in different regions and at different seasons. Thus, easterly winds in one country may convey dry heat, in another country dry or moist cold, and in a third moist warmth; and in the same country it may be a hot wind in summer and a cold wind in winter, thus showing that the characteristics of the winds have to be studied separately for each place. The influence of winds is well shown in the British Isles and in Brittany. The south-west winds are for these regions equatorial currents, and therefore bringing warmth; and as they pass on their way over the Atlantic, and more especially the Gulf Stream, they are saturated with moisture, and therefore bring to these countries moist warmth in winter; and the air of the land being colder, part of the moisture must condense and give rise to fogs, clouds, and rain. The winter temperature of these countries, compared with other districts situated in the same parallel of latitude, is considerably raised, owing to the prevalence of these winds, the moisture conveyed by them, at the same time, diminishing radiation and causing a more equable temperature. As a consequence the meadows rarely lose their green appearance, and many evergreen shrubs, such as rhododendrons, laurels, and myrtles, grow in the open air, which require artificial warmth at many places of the European continent lying much more to the south. In summer, on the other hand, these south-west winds, blowing, as they do, over the sea, which is cooler than the continent, bring moisture to and lower the temperature of the land, thus producing cooler days in summer, continuously high temperatures being rare at that season. The air, being moist, also gives rise to the formation of clouds, and thus lessens the force of the direct sun's rays. Hence such plants as require continuous summer heat grow badly, and the cultivation of the vine, for instance, is a matter of impossibility. The south-west winds also raise the temperature in winter and lower it in summer, thus producing a more equable but somewhat dull and damp climate. The east and north-east winds, on the other hand, blowing over the north-east of Europe and the adjoining parts of Asia, where cold reigns in winter and heat in summer, bring these characteristics, though somewhat modi-

fied, to the British Isles. As a consequence, winters in which south-west winds prevail are conspicuously warm in England and Brittany, whilst at the same season the prevalence of east and south-east winds lowers the temperature and makes the air drier. Conversely, in summer these countries have comparatively low temperatures, with much rain, when south-west winds prevail, and the opposite obtains on the prevalence of east and north-east winds. It is, therefore, necessary to know how often winds of a certain kind blow at a health resort, to what extent such a place is exposed to or protected from them, and in what way the winds are modified by the configuration of the neighbourhood. According to the temperature and moisture of the current and its velocity, which may vary from one foot to 120 or 150 feet per second, more or less heat is abstracted from the body, and more or less moisture evaporates from its surface. Cold currents of some strength are, therefore, dangerous to invalids suffering from affections of the lungs, rheumatism, and gout, whilst moderate currents act beneficially, especially in warm weather. Their bracing effects being more or less pronounced, they render a climate stimulating, require some accommodating power on the part of the organism, and keep it in training; on the other hand, the existence of a certain amount of bodily vigour is necessary.

VI. *THE ELECTRICAL CONDITIONS OF THE ATMOSPHERE.*

The electricity of the earth seems to be always negative, while that of the atmosphere is almost invariably positive. Of 10,500 observations made at Kew during the years 1845–47 positive electricity was found 10,176 times and negative electricity only 364 times. When the sky is clear the electricity is always positive, whilst the few results showing negative electricity to be present are almost all obtained during heavy showers of rain; during fogs, on the other hand, according to Schübler, the electricity is highly positive. It is stronger in projecting and highly pointed objects and conical mountains, stronger at a distance from than near the ground (Petier,

Electricity.

Quetelet, Becquerel, and Breschet), and stronger on heights than on lowlands. The electricity of the atmosphere is stronger in winter than in summer, and is strongest in January, decreasing from this month to June and then increasing again to January. Like moisture and warmth, with which it is closely connected, it is subject to diurnal periodical variations—that is, to a double maximum and minimum (Saussure and Schübler). It rises from daybreak to the first maximum between 6 and 8 A.M. in summer, and at about 10 A.M. in winter; it then falls to the first minimum between 4 and 6 P.M. in summer, and at about 3 P.M. in winter; it rises to a second maximum 1½ to 2 hours after sunset, and then decreases to a second minimum, which is reached about daybreak. The sources of electricity are said to be evaporation, vegetation, oxidation, and other chemical processes, and friction. According to Peltier and Lamont, however, the negative electricity of the earth's surface seems to be the chief agent in the production of the electricity of the atmosphere when it contains aqueous vapour.

The connection between the electricity of the air and of the clouds with thunder storms is well known, but it does not follow that with increased electricity in the air there is a greater number of thunder storms; on the contrary, in winter, with more electricity, thunder storms are rarer than on lower or moderate elevations, as shown by Plantamour by comparing Geneva with the hospice on the Great St. Bernard, the average annual number of thunder storms being twenty-five or twenty-six in Geneva, and only seven at the hospice.

The physiological and pathological effects of the different variations of atmospheric electricity are probably of great importance, but unfortunately we have no accurate knowledge regarding these points.

GENERAL CONSIDERATIONS ON CLIMATIC INFLUENCES.

If in the preceding paragraphs the different elements or factors of climate were considered separately, this was done simply with the view of elucidating to a certain degree the

part which individual elements take in it. We must not, however, imagine that in nature—that is, in the climate of a place —any single element exists by itself; but these factors always act more or less together, depend on one another, and are in close mutual relations. According to the prevalence of one or the other element, or rather of one or the other group of elements, a combined effect is produced, differing and changing without limit, and called in popular phraseology *weather*. If we bear in mind how important the 'weather' is to individuals and to a country, we cannot wonder at its being the constant topic of conversation. Goethe says that on occasions when medical men meet non-medicals it is very natural for the conversation to turn almost constantly to matters relating to health or medicine, because these subjects are of the greatest use to all the members. This remark would apply even more to the weather, which makes itself felt continually, and the origin of which appears so obscure. The kind of weather which prevails in any region or at any place during different years, seasons, months, days, and at different times of the day constitutes the chief characteristics of the climate of a region or place, or of a certain part of it.

Weather and climate.

We have already explained that the chief characteristics of the climate of any place are due to its latitude, and that, supposing the earth were a uniform sphere, the climate of any place could be determined from the relative position of the earth to the sun at any given time. To a certain extent the character of a climate depends thereon, especially as regards the length of day and night; whilst the temperature, moisture, and pressure of the air, the amount of light and of winds, differ frequently, owing to secondary influences, from the condition as arrived at by inference. Among these secondary or modifying influences ranks first the fact that the earth's surface consists partly of land and partly of water, whilst the conditions as regards heating, radiation, and cooling differ in each case, and the distribution of land and water is very irregular.

Influences modifying a climate.

We have pointed out above (p. 17) the effects of water at different temperatures and the action of ocean currents—on the one hand of the warm currents, such as

Influence of the sea.

the Gulf Stream, which in higher latitudes raise the temperature in winter and lower it in summer; and, on the other hand, of the cold or polar currents, which reduce the temperature of the coasts washed by them, causing their isotherms to dip down towards the equator, as may be well seen on the east coasts of North America and Asia.

At this place we have also to consider briefly the effects of large tracts of water in the interior of a continent. In the paragraph on the influence of warmth on water we have indicated the greater capacity of water for warmth, the evaporation on the surface owing to the sun's heat, and the circumstance that the strata of air over water take up less heat during the day and part with their heat less readily at night. Hence air currents are produced, for the air over the shore, being more heated, rises during the day, and the air over the surface of the lake is drawn to the shore by aspiration, whilst the opposite obtains at night. Consequently the climate of the coast line round large sheets of water is more equable in summer than the climate of places having the same elevation but situated at a greater distance, whilst the summers are also cooler and damper. Towards the end of autumn, and in winter, the coast districts cool down more quickly than the surface of the lakes; a current sets in from the land towards the lake, and hence the land is no longer warmed by the stratum of air over the lake, except when a wind blowing across the lake carries to the land the damper and moister atmosphere. With this reservation it may be laid down as a rule that inland lakes in autumn and winter have no tendency to raise the temperature of the adjoining coast districts. When they are frozen in winter their influence can scarcely be distinguished from that of frozen land; if, however, they remain covered with ice in spring, their effect is similar to that of snow and ice fields—that is, they chill the air passing over them, and through it the surrounding districts, thus giving occasion to cold and late springs, as is the case in the region of the great inland lakes of North America.

Inland lakes.

In a general way it may, therefore, be said that with some exceptions the presence of large tracts of water has a lowering effect on the mean annual temperature of the surrounding

regions, chiefly owing to their diminishing the summer temperature.

Large tracts of continental land.

In contrast to the influence of the sea on climate, that of large tracts of continental land is this: The land is more heated by the sun during the long days in summer; on the other hand, the cold in winter is more considerable in higher latitudes, because little heat is received from the sun and much is given off by radiation, this latter being more active owing to the circumstance that the comparatively dry atmosphere and the frequent absence of clouds present no great obstacles to the escape of the heat radiated from the earth. Hence centres of cold with increased atmospheric pressure form in the great continents of higher latitudes, such as in the north-east of Europe and the adjoining parts of Asia and in the north of America, whence cold winds stream towards the regions with a lower atmospheric pressure. To this cause must be attributed the cold north-east winds which during spring blow in the British Isles and over the whole of the west of Europe, being also felt in the centre of the continent. In summer the opposite obtains, the pressure of the air being diminished in the middle of Asia, and winds flowing from all directions into that area of depression. The prevalence of west and south-west winds in the west of Europe partly depends thereon; and these currents coming from the sea, and being therefore cooler and moister, have the effect of making the summer months less hot, less dry, and less sunny. The conditions with regard to the North American continent are similar, with the exception that there the large lakes exert a modifying influence, particularly in summer, by reducing the temperature to a certain extent. These vast continents of the higher latitudes exhibit, accordingly, very great differences between summer and winter, and influence the climate of the neighbouring districts in the way mentioned, even for a considerable distance. Vast continents in the region of the tropics are heated to a considerable degree in daytime, owing to the influence of the sun, and frequently undergo a considerable fall of temperature at night; thus the Sahara, in North Africa, has a heating and drying effect on the neighbouring regions when the winds come from it. The same applies to the Australian continent.

On a former occasion we have drawn attention to the influence exerted by the elevation of a place on its temperature, moisture, and barometrical conditions; but there are other effects due to the configuration of the surface.

Configuration of the surface.

Arid plains of great extent become heated and cool down uniformly. In the absence of winds the cold stratum of air remains at rest over the ground, thus causing great differences between the heat of the day and the cold of the night, but less variety in the moisture. If, on the other hand, the plains are damp and marshy, the heat causes aqueous vapour to rise, which on arriving at the higher and colder strata of air condenses into mist and clouds, whilst extensive fogs must form near to the ground when the lower strata cool down.

Plains.

In hilly districts—that is to say, in regions where hills of moderate elevations alternate with valleys—the case is different. Even if soil and vegetation are the same there is a difference in the amount of heat received from the sun, in radiation, and in currents, thus causing, according to the locality, different conditions which find their explanation in the physical laws of heat, pressure, &c., and are of great importance with regard to the local climate of differently situated dwellings. In a general way it may be said that in hilly districts, owing to the unequal heating and the currents caused thereby, the conditions of temperature and moisture are subject to more frequent changes, that they have a tendency to equalise, and are less extreme than on large plains.

Hilly districts.

Isolated mountains influence their surroundings differently according to the weather. During clear sunshine the summit is soon heated, radiates heat into the surrounding air, and lowers its relative moisture; when the sun ceases to shine it quickly cools by radiation, lowers the temperature of the surrounding air, and increases its relative moisture, thus sometimes giving rise to the formation of clouds. Accordingly it produces extremes of temperature and moisture in the surrounding atmosphere when the sky is clear, whilst these effects are wanting when it is overcast, and take place only to a very limited degree when there is a wind, owing to the

Influence of isolated mountains.

rapidly equalising effect of the latter. Compared with low-lying inland places of the same latitude, the climatic characteristics of high isolated mountains are as follows (proper correction for altitude having been made): No great extremes of temperature in the course of the year, less cold in winter and less heat in summer, and a clearer sky. This will also, as a rule, hold good in comparing them with low-lying places in higher latitudes or with stations having the same altitude but situated in valleys.

Influence of mountain ranges.

The influence of groups or ranges of mountains is very different according to height, extent, slope, exposure, vegetation, configuration of the surrounding valleys, &c. In all mountainous districts and mountain ranges there are certain regions of cloud, where, during the warm months, part of the moisture rising from below is condensed. The stratum of cloud thus formed has the effect of lessening the extremes by diminishing solar and terrestrial radiation, and gives rise to a modification in the law that temperature decreases with increasing height, the rate of decrease being less in the region of clouds, as the author himself had repeatedly occasion to verify.

Influence of mountain ranges on moist winds.

In contrast to this stratum of cloud, which arises owing to the ascent of warmed air, is the formation of clouds on the windward slopes of mountain ranges, which is caused by moist winds striking against the slopes, ascending on them, and passing over the summit of the ridge. In the case of these ascending winds the air is cooled partly by arriving at colder regions and partly by expanding in consequence of diminished air pressure. The result of this cooling of the air is that a variable portion of its moisture is condensed into cloud, rain, or snow. The wind arriving on the summit descends on the leeward slope of the mountain, or range of mountains, in a variable, slanting direction (Germ. *Windfall*), and not straight down the slope. The air becomes condensed during its passage and gets warmer in descending, just as it became colder in ascending, and loses in relative humidity at the same time, owing to the greater capacity of warmer air for moisture. Hence a wind which is warm and moist on the windward side of the range becomes a dry wind to the leeward, as has been shown by Dove and others with regard to the

Föhn. Dove's and Mühry's investigations on the subject of winds, and the lucid exposition given by Lorenz and Rothe, are very instructive. The stratum of air between the mountain slope and the *Windfall* is called *windshade.* The distance at which the *Windfall* reaches the ground amounts, according to Mühry, to 60 or 80 times the height of the range over which the wind has passed, but is in many cases less by one-half, depending partly on the temperature prevailing in the windshade. Owing to the abstraction of moisture from the air by ranges of mountains situated to the windward, the climate of a region is drier to the leeward, and the extremes are greater, as is shown in Norway and Sweden to the windward and leeward of the Dovre Fjeld mountains. In some cases ranges of mountains afford protection from winds by diverting them; in others they lead to a diminution in the amount of sunshine, with its consequences, and to many effects confined to a limited area which have to be considered separately according to the individual cases.

Characteristics of plateaux.

The climatic characteristics of *plateaux* vary a good deal, but they are, on the whole, due to their elevation and to the peculiar feature of plains. When the sky is clear they become heated rather quickly and uniformly during the day, lateral currents being rare, whilst at night they cool rapidly; hence great extremes of temperature and moisture prevail. In winter, owing to clouds or mists frequently diminishing radiation, the average temperature is not so low as at other places of the same elevation above the sea level; and the mean annual temperature is somewhat higher, being considerably so in some situations (Rocky Mountains).

Distinctive features of valleys.

The greatest diversity is met with in *valleys*, according to their direction, the manner in which they commence and end, the protection they afford from cold and moist winds, and according to the height and slope of the mountains on either side; each valley has indeed its special features. Of great importance is the length of time they enjoy sunshine, and its intensity, which depend on the height of the mountain walls in the direction of the sun, on the breadth of the valley and its direction to the points of the compass. In *broad* valleys insolation is very powerful, and its

effect is increased by reflection from the slopes on which the sun shines; radiation is also powerful when the sun is withdrawn, and the consequent cooling is increased by the descent of cold air along the slopes. Therefore greater extremes of temperature and moisture are met with in such valleys, as regards diurnal range, than on the slopes and summits of mountains. Moreover, in autumn, winter, and spring the lower valleys are frequently covered by mist, whilst the upper slopes and peaks are exposed to the sun; and, in addition, snow mostly remains longer in the valleys than on the sunny slopes. Hence the winter temperature at the mountain stations of Switzerland is generally not so low, and the summer temperature not so high, as at stations having the same elevation, but situated in valleys; thus, for instance, at the mountain station of Rigi Kulm the cold in winter is less by several degrees, and the warmth in summer greater by three degrees, than at Bevers, in the valley of the Upper Engadine. *Narrow, ravine-like* valleys, on the other hand, allow only little sunshine to penetrate to the bottom of the valley, thus being less heated during the day, and giving off less heat at night by radiation, the amount of the latter being further diminished owing to the fact that the air in the ravines is more saturated with moisture by the rivulets and the dampness of the soil. Such narrow valleys are frequently a source of fogs and clouds for the mountainous districts in the neighbourhood, the climatic conditions of which are thereby rendered less excessive.

Position as regards sun and winds.

It is of great importance to the climatic conditions of a place, whether it lies on the sunny or shady side of a mountain range. In the northern hemisphere the sunny side comprises the slopes with a S.E., S., or S.W. aspect, and the shady side those facing N.E., N., and N.W. On this depends the period and duration of sunshine, which change according to the seasons. The sun's power, however, is modified by the inclination of the slope, the vertical rays of the sun imparting more heat than those falling on the surface of the ground obliquely. The snow line is higher on the sunny than on the shady side, the difference in height amounting in some regions to between 1,500 and 3,000 feet. The snow melts in spring on the sunny side for weeks, and even months, sooner.

On the other hand, temperature and moisture are subject to greater variations than on the shady side. Generally speaking, in the northern hemisphere the south-western side is the warmest, and the north-eastern side the coldest, whilst the western is mostly somewhat warmer than the eastern side.

Besides sunshine, the direction towards the prevailing winds is important, particularly regarding the moisture they contain. In Europe the south-western slopes, although receiving less warmth, are mostly less dry than the south-eastern slopes, and some regions are therefore less warm at certain seasons; thus, according to Kerner, the south-western slopes in the neighbourhood of Innsbruck are mostly cooler in summer than the south-eastern slopes.

Influence of mountain ranges on the adjoining districts.

We have described above the effect of higher ranges of mountains on winds, particularly in wringing out of them part of their moisture. The currents originating in the mountains themselves also exercise a corresponding influence on the adjoining districts. An instance is afforded by the mountain and valley winds, as explained in the chapter on 'Winds;' similar currents being considerably modified according to different regions.

A further influence, as will be easily understood, is caused by the chilling effect large fields of snow or ice have on currents passing over them, and carrying this cold to other districts. Not only do the permanent ice fields exercise such an influence, but also snow melting early or falling late, as the case may be. The effects of such icy winds will be familiar to many of those who have travelled in districts to the south or north of the Alps or Pyrenees; they are particularly noticeable in spring and autumn, and, as a consequence, the climate of regions adjoining ranges of higher mountains affords during these seasons frequent contrasts between warm sunshine and damp cold arising suddenly.

Condition of the soil.

The influence of the soil on the temperature and moisture of the lower strata of the air is manifold even if the inclination of the surface is the same; the quantity of moisture which it absorbs, the rate at which it allows the water to percolate, the rate at which evaporation takes place, the capacity for warmth, and finally the rapidity with which

the ground is heated or cools down vary with the condition of the soil.

The mean temperature of the ground, if it is not covered by much snow, and if the quantity of rain is pretty equally distributed, is almost identical with that of the air; but if the ground remains covered with snow for a great part of the year, it is warmer than the lower strata of air; thus its mean annual temperature in Semipalatinsk, in the south-west of Siberia, is 9° F. warmer than that of the air. The diurnal variations of temperature of the air do not penetrate more than 3 feet into the ground, varying according to the rate of the external change of temperature. The variations attending the different seasons penetrate to a greater depth; but, according to observations made by Forbes, not more than 36 feet at Edinburgh, and at a depth of but 23 feet they are scarcely noticeable; deep in the ground they take place later than on the surface. Thus Forbes found in Edinburgh in January the greatest warmth at the depth of 23 feet and in July the greatest cold; J. D. Everett found in Greenwich, at a slightly greater depth, the highest temperature in November, and the lowest in the beginning of June; whilst at a depth of $11\frac{1}{4}$ feet he found the highest on September 25, and the lowest on March 27.

Professor James Elliot's experiments with different kinds of soil show that dry clay can absorb its own weight of water, dry garden mould more than half its own weight, and dry sand little more than a third of its own weight; also that under the same circumstances sand loses the water it contains more quickly than garden mould, and the latter loses it more quickly than clay. Light-coloured, dense, and moist soil is warmed less quickly than dark and loose sandy soil, but loses its warmth more slowly in the evening. Rocks do not become so hot as sandy soil, because, being better conductors of heat, they conduct part of the heat to lower regions.

According to A. Buchan the effect of drainage on the temperature of the soil is the following:—(1) The mean annual temperature of arable land is raised nearly a degree (0·8°) by drainage. (2) The temperature of pasture land is also raised, but not to the same extent (0·4°). (3) Drained land loses less heat by evaporation. (4) The tem-

Effect of drainage.

perature of drained land is less subject to fluctuations. (5) The temperature of drained land is in summer often raised between 1·5° and 3° above undrained. As the temperature of the air depends considerably on that of the soil, and as the relative humidity is also in relation to it, it can easily be understood that draining of the soil has a decided effect on some constitutions.

As to the influence of the soil, and the moisture contained in it, on the origin and spread of different diseases, the researches of Pettenkofer, Bowditch, Buchanan, and others have furnished us with valuable information, though we cannot here enter into a detailed account of them.

Covering of the ground by vegetation.

The difference in the temperature and moisture of the air over soils bare of vegetation, or more or less covered with plants, is often very great, and varies according to the kind of covering and the times of the day and year. The different kinds of vegetable covering we will consider under three divisions—(1) forest land, (2) pasture land, (3) marsh land.

Influence of forests.

1. Much has been done by the valuable observations of Ebermayer in elucidation of the influence of *forests* on the air and soil. As regards woodland soil, its mean annual temperature from the surface to a depth of four feet is several degrees lower than in the open country outside the forest, the difference amounting in some cases even to 20 or 21 per cent., and the lowering of temperature, as regards Bavaria, being most pronounced in summer, less in spring, still less in autumn, and very slight in winter. The *air* in the forest itself is in the yearly average somewhat cooler than in the open country outside, the difference varying according to the nature of the forest and the elevation of the ground above the sea level, and amounting on an average to almost 10 per cent. In winter it is low during the day, whilst during the night the air in the forest is somewhat warmer; in spring the forest air is on an average 2° F. cooler; and in summer the lowering of temperature is greatest, averaging from 3·5° to 4·5°, and being much greater (9° to 11°) during the heat of the day, and less in the evening and at night, when the temperature inside a forest may be even higher than in the open

country. In autumn the air inside a forest is 0·9° cooler in the day and from 0·3° to 0·5° warmer at night. As regards moisture, Ebermayer came to the following results: Evaporation in forests proceeds twice, or three times, as slowly as in the open country; the *absolute* humidity is little altered, but the *relative* humidity is always increased—viz. on an average 6 per cent., in the hottest month (July) even 10 per cent. and in the coldest (January) 3·77 per cent., variations taking place according to the extent of the woodland and the different nature of the surrounding land (whether dry heath or damp pasture), and being more pronounced in elevated positions (for instance, on mountains and mountain slopes) than on lowlands. Hence, in a general sense, it may be held that the climate of woodlands is more equable as regards the differences between day and night; that the heating by the sun is less, and that it does not occur till the later hours of the day; that the relative humidity is in excess, and that precipitation is increased. This latter fact can be easily understood on considering that the air in forests is some degrees cooler than the air in the open country, and that it is nearer saturation, so that in air currents which are nearly saturated, part of the moisture must condense on their entering the cooler forest. In deciduous (leaf-shedding) forests these effects are chiefly confined to the time when they are in leaf, but in evergreen forests they extend more or less over the whole year. Apart from its temperature and moisture, the air in forests has other characteristics which, although not yet measured, are nevertheless important to health. We would mention the changes in the air caused by the exhalations from the leaves, and affecting its proportions of ozone, oxygen, and carbonic acid; other, particularly resinous, exhalations from the trees; and, owing to more frequent precipitates, the purification of the air from different admixtures. Added to that is the fact that they moderate the light from the sun, thus affording during summer a valuable therapeutic agent. More important still to the physician is the shelter from winds enjoyed in the forest itself and its near proximity. This shelter from winds does not only apply to the permanent, but also to temporary winds arising from local causes; thus on cold winter days the author had repeatedly occasion to observe that of tender exotic

shrubs those which stood below woods of fir trees remained uninjured, whilst those at the base of an uncovered slope had perished by the cold. This phenomenon is explained by the fact that the cold currents descending on the slopes during the night are stopped or mitigated by woods, whilst uncovered slopes do not afford such a protecting and moderating influence. We are thus furnished with valuable hints as to the selection of sites for dwelling-houses.

The influences of forests and abundance of trees on the surrounding country have still to be more accurately studied; we may, however, state that greater humidity, increased precipitation, and lowering of the extremes are caused by them.

Pasture land.

2. Under the term grass or pasture land we include land covered by grass, clover, and other low plants standing close together. The soil of such land cannot in summer become heated by the sun to the same extent as a bare plain, because the sun's rays do not strike the ground itself, whilst the plants continually give off heat by evaporation. In taking the temperature of the air over a tract of arid sandy soil, and over meadow land beside it, we have recorded in one instance for the air over sand 111° and over meadow land 77° F.; in another instance 107·5° and 70° respectively; in a third 104° against 71·5°, and also in other cases considerable differences, though not equally high. Radiation at night is much more energetic on meadow land, in consequence of the great extent of radiating surface afforded by the many pointed grass leaves, thus leading to rapid cooling and the frequent formation of mist, dew, or hoar frost. Generally speaking, we may, therefore, state that tracts of meadow land lower the temperature in summer, and increase the moisture in the air, whilst when the grass is dried up, or when the soil is frozen in winter, the difference is only small. Probably there are yet other effects, due to the processes of vegetation in meadow land, that have to be taken into account beside its action on the temperature and moisture of the air.

Marsh land.

3. In the case of marsh land the soil is always wet; the air over it has a greater relative and absolute humidity than the air over arable land, and its temperature is lowered by evaporation; and the ground in the evening, at

night, and in the early morning is frequently covered by fog. Added to this is in many cases the presence of malaria, rendering similar districts in most cases unfit for invalids, unless the supposed antagonism between malaria and phthisis should lead some physicians to attribute a special influence to such climates. The influence of marshy districts, however, is not confined to the marshes themselves, but, owing to air currents, it extends to long distances over level and hilly ground, and even to a certain, though not great, elevation above the level of the sea.

II.

CLASSIFICATION OF CLIMATES.

Every classification of climates is defective, more so even than the classification of drugs or diseases. The old division into zones is indeed very simple, but useless for therapeutical purposes, because (as is indeed shown by the isothermal lines) within the area of two parallels of latitude may be comprised a great variety of climates, according to the elevation of the ground, its situation near the sea or inland, or on the east or west coast of a continent.

Modes of division.

A classification based on the mean temperature of different districts—that is, the isotherms—has some advantages for medical purposes, and has been adopted in several excellent works by French authors. For instance, Michel Lévy ('Traité d'Hygiène publique et privée,' 1869) recognises seven climates—

1. Torrid or very hot climates; mean temperature 81·5° to 77° F.
2. Hot climates; 77° to 68°.
3. Warm climates; 68° to 59°.
4. Temperate climates; 59° to 50°.
5. Cold climates; 50° to 41°.
6. Very cold climates; 41° to 32°.
7. Glacial climates, with a mean temperature below freezing point.

The same author, in a more recent publication, gives a more simple classification, by dividing the earth's climates into three large zones—

a. From the equator to the 30th and 35th parallels north and south respectively.

b. From the parallels mentioned to the 55th parallel north and south.

c. From the 55th parallel to the poles.

Jules Rochard (article 'Climat,' in 'Nouveau Dictionnaire de Méd. et de Chir.,' t. viii., 1868) recognises five climates—

1. Torrid or very warm climates, extending from the equator to the isothermal lines of 77° F. north and south.
2. Warm climates, from the isotherms of 77° to those of 59°.
3. Temperate climates, between the isotherms of 59° and 41°.
4. Cold climates, between the isotherms of 41° and 23°.
5. Polar climates, between the isotherms of 23° and 5°.

This classification has also been adopted by other French authors, such as Fonssangrives and Lacassagne. But, although it has the advantage of being perspicuous, it has but a limited value for the physician, because very different climates have the same mean annual temperature. It simply shows the quantity of warmth received by a certain district or place in the course of a year, but it does not indicate the way in which this warmth is distributed over the different periods of the year or day. Amongst places having a mean annual temperature of from 48° to 50° F. may be included places with mild winters and cold summers, and places with cold winters and very warm summers may equally show the same mean annual temperature. The difference of temperature between summer and winter may be only 20° F. or less, or it may amount to 40° and more. We will take as an example London and Odessa, because they are well known, though there are other places having the same mean annual temperature with much greater differences. Both places have a mean annual temperature of somewhat over 48° F., but their seasons, particularly summer and winter, show a considerable difference.

	Spring	Summer	Autumn	Winter
London	46·4°	59·9°	49·3°	37·6°
Odessa	45·7°	70°	50·7°	27·5°

The difference between summer and winter in London is 22·3°, in Odessa 41·4°. At different places on the south-western coast of England, and at many places on the Irish

coast, the difference is even less than in London; in Dublin, for instance, it is only 16·47° (winter 9·41°, summer 25·88°).

Of greater importance for the physician is the mean temperature for each *season* of the year, because invalids are, as a rule, sent to climatic resorts only for certain seasons. Places, however, with the same mean temperature for winter or autumn may show very great differences as regards changes of temperature from one period to another—that is to say, from one week to another, or from one day to another, or from one period of the day to another. Therefore the division of climates according to the mean temperature of different seasons is equally insufficient.

But even were the conditions of temperature of different places accurately given by the mean temperature of the seasons, any classification based on that principle must be incomplete, because other important factors—the humidity of the air, its purity, density, degree of motion, its conditions of light and of electricity—would not be taken into account.

The humidity of the air constitutes an important element, as we have seen above; and Von Vivenot, Walshe, Rohden, C. T. Williams, P. Niemeyer, Thomas, Biermann, and others justly lay great stress on *relative humidity* in estimating the climatic value of a given place. For this factor is closely connected with the fluctuations of temperature, the diathermanous state of the air, and its conditions regarding ozone, light, and electricity. It also materially affects evaporation, and thus has a direct and powerful influence on the organism. The proposition of Thomas,[1] however, to make the relative humidity the chief basis of classification of climates fails, because sufficient notice is not taken of the other climatic elements.

For the same reason a division cannot be based on barometrical pressure or its fluctuations, nor on any other of the climatic elements taken separately, for every climate comprises not one but all—that is, a great many elements which are constantly changing and by their mutual relations produce an ever-varying whole.

The deficiencies connected with every kind of classification

[1] *Vierteljahrschrift der Klimatologie*, 1876.

appear to us so great that we might almost feel disposed to proceed alphabetically, but this would require many repetitions and would be unsuited to a compendium. We therefore will make the attempt to classify in different groups, which are marked by prominent physico-geographical characteristics. Such a division must necessarily be incomplete and arbitrary, partly on account of our defective knowledge of the different climates, partly also for the reason that a given place might belong to two or more groups, according to the season of the year, and because in different years the same place may present great variations in its climate (weather).

Hence we recognise two principal groups of great extent—

A. Marine climates.

B. Inland climates.

A. *MARINE CLIMATES.*

In this division we shall consider islands of limited size that are exposed to the full influence of the sea air, and maritime coasts, which are powerfully influenced by the sea, though the adjacent parts of the continent share more or less in determining the character of these climates. Under the same category may be classed the atmosphere over the sea as met with on board ship; but, on account of several peculiarities, sea voyages will be treated separately in another part.[1] Such localities differ greatly in climate, according to their distance from the equator and the currents to which they are exposed, but a great many conditions are common to all of them. To begin with, they have, with very few exceptions, a *more equal temperature* than inland places; the difference between summer and winter is less, and also that between day and night. As we have shown above, it results from the physical conditions of water, that during the day the sea absorbs much more heat, the sun's rays penetrating deeply, while on land they simply heat the surface and are reflected by it. It also follows that during the day the surface of the sea

General characteristics.

[1] Dr. C. Faber, of Stuttgart, was to have written an article on Sea Voyages; but it did not appear in Ziemssen's *Therapeutics*, and we are informed that Dr. Faber intends to treat the subject in a separate work.—*Tr.*

cannot get so much heated, because by copious evaporation warmth is used up (becomes latent); by night, however, the cooling of the surface of the sea is less, radiation into space being limited by a considerable layer of vapour, while on land heat can more readily escape. In winter the air above the sea cannot become so cold as inland, because the water of the sea has been heated to a considerable depth, the cold layers of the surface sinking and being replaced by lighter and warmer portions rising from beneath.

The *moisture* above the sea is increased by constant evaporation, which varies according to the sun's heat, the degree of saturation, and the amount of wind. In the degree of relative humidity too there is more equability, the air conveyed by the winds being always to a certain degree saturated with moisture from the sea.

The *atmospheric pressure*, or the density of the air, is always high on the sea; its fluctuations are considerable and very regular. On small islands and on the sea shore generally the air is mostly kept in motion to a certain extent by local winds, due to the unequal warming and cooling of the sea and land by day and night. These winds vary in force according to the amount of the sun's heat. Besides these local winds there are, of course, the general winds caused by more distant conditions. The amount of *light* is considerable, but variously moderated at different places by the quantity of moisture in the atmosphere.

The *electricity* is considered to be more usually negative, and to become neutralised more insensibly and easily than in the case of inland climates. The *amount of ozone* is invariably very high, owing to the influence of sunlight, evaporation, and currents of air. The refreshing effect of the sea air on general health seems to be due to some extent to the increased proportion of ozone combined with strong currents of air and abundant evaporation.

The air is *free from dust*, whether consisting of coarse mineral or organic particles. This does not apply, however, to certain malarious districts not made use of for therapeutical purposes.

According to the locality and the force of winds, *foreign substances* are mingled with the sea air in various proportions,

particularly chloride of sodium and, in minute quantities, bromine and iodine.

To sum up, the characteristic properties of sea air are—slighter variations of temperature and moisture, the amount of the latter being considerable; high atmospheric pressure, with regular fluctuations; periodic currents of air; the tendency of electricity to become neutralised; abundance of ozone; absence of inorganic dust and organic impurities; and the presence in variable proportions of chloride of sodium, bromine, and iodine.

Of the physiological action we have less accurate knowledge, but some data were furnished by Beneke's valuable investigations. This author has shown that, other conditions being equal, a given quantity of a heated liquid cools more rapidly at the sea shore than inland, and particularly in the case of elevated regions. Hence he infers that the body loses more heat at the sea, which fully accords with the daily experience that to sit in the open air without feeling discomfort, the temperature being the same, requires more clothing at the sea than on mountains. Beneke, making his observations at the Isle of Norderney, situated in the North Sea, further proved that the urea and sulphuric acid in the urine were augmented, phosphoric and uric acids became less in amount, and that the quantity of urine secreted was, with increase of bodily weight, increased. He also established that these results were owing much more to the effects of sea air than to sea bathing. The currents of air produced by the local winds may have a good deal to do with it. According to our own experience, as well as that of others, most persons exhibit a slight diminution in the frequency of respiration and of the pulse, when at the seaside, compared with a residence inland at an elevation of between 1,000 and 3,000 feet, which fact may be explained by the greater atmospheric pressure and the increased moisture of the air. Sleep and appetite are generally increased, but this rule is subject to many exceptions. Particularly at the beginning of their stay, some persons exhibit an irritable state of the nervous system, sleeplessness, obstruction of the bowels, and biliousness. Increased formation of blood, strengthening of the nervous, circulatory, and cutaneous systems, are in suitable cases the results of a prolonged stay in

Physiological action.

sea climates. It may, therefore, be said that sea climates have a sedative, and at the same time tonic, effect, but this is to be understood only in quite a general sense and subject to many gradations.

Therapeutical applications.

Sea climates may be recommended for many conditions, such as disturbances in blood formation, hydræmia, anæmia, and affections resulting therefrom, like amenorrhœa and menostasis; for persons with a liability to catch cold owing to susceptibility of the skin and mucous membranes, resulting in rheumatism and catarrh; where tissue changes and general nutrition are impaired, as in scrofulous disease; in surgical cases with slowly healing wounds; in some forms of excessive irritability of the nervous system and sleeplessness; in many cases of debility from long-standing disease and exhaustion by over-work or depressing influences. Sea climates are of inestimable value for the physical development of weakly children or those who have a tendency to scrofula. Residence at the seaside for several months every year is sufficient in the case of many families to counteract the tendency to scrofula and phthisis, but in others it is necessary for them to reside at the seaside for several years in succession, and only go inland occasionally for the sake of change. One must bear in mind, however, that sea climates only suit those endowed with a certain amount of endurance and a fair digestion and assimilation, and that they are not adapted to cases of serious disturbance of the circulatory system. In many forms of weakness of the heart, with a tendency to venous obstruction, great care must be used during residence at the sea, and in most of these cases purgatives must be given freely for the relief of the circulation. Serious forms of asthma and hysteria are quite unsuited for a sojourn at the sea, and some skin affections, like eczema, generally get worse.

Subdivisions of sea climates.

There are so many varieties in the climatic conditions of the different places belonging to the great class of sea, island, and coast climates that we must make several subdivisions. Here we are again met by the difficulty of deciding what principles should guide us in making these subdivisions. The climate of the same place differs very much in different seasons. Moreover, in large islands different parts

of the coast afford different climates, and besides the character of the climate varies considerably according to the elevation above the sea level and the distance from the shore, so that different parts of the same islands belong to different climatic subdivisions. In many cases one may therefore be uncertain under which subdivision a place is to be grouped ; sometimes the same place may be added to one division for winter, and to another for summer. Even different parts of the same place vary so much in character that they may be assigned to different climatic groups.

On account of the great influence atmospheric moisture has on the equability of climates, and bearing in mind the direct effects of humidity on many functions of the body, we will follow Theodore Williams, Biermann, and Thomas in basing our division on atmospheric moisture, and further subdivisions on temperature. But we must premise that in speaking of *moist*, *moderately moist*, and *dry climates* we are guided by considerations for which simple numbers cannot be substituted. For instance, the humidity of a climate cannot be estimated from the amount of rainfall alone, for in many subtropical places the fall of rain is great, although the air is rather dry. Heavy torrents of rain, too, may take place in the course of a few hours, soon followed by bright sunshine ; whereas, at other places, e.g. at the north-western coast of Europe, the same amount of rain is distributed over several weeks, and accompanied by a dull sky or drizzling fog. In the case of the former we meet with limited vegetation, arid plains during the greatest part of the year, and the maturing of fruits which require a good deal of sunshine and warmth (oranges and lemons); in the latter case, with luxurious pasture grounds and trees with abundant foliage, whilst such flowers and fruits as require much sun do not thrive.

Of greater import is the *number of rainy days*, but even the term 'rainy days' must be differently interpreted according to locality. At many places on the Mediterranean it rarely rains for the whole day, some hours of heavy rainfall being mostly succeeded by hours of sunshine ; whereas in the interior of Germany, in France, and still more in England and Ireland, moderate rain takes place almost continually for a number of

days. This circumstance tells on the mental organisation of weakly persons considerably, and influences them further by interfering with outdoor exercise and making it less agreeable.

The *relative humidity*, too, even were it known for all places, can only be taken as a standard if other conditions, and particularly the temperature, be considered at the same time. In hot regions, air, with between 80 and 85 per cent. of humidity, is obviously moist, while in cold regions the same degree of humidity must be termed as moderate. In cold climates or at a high altitude, where temperature is low, at a mean humidity of 80 per cent. the body loses, chiefly by way of the lungs, much more water than in warm climates at the same degree of saturation, for the air respired, being of a low temperature, is warmed in the lungs to about 86° F., and nearly saturated with moisture.

If we recognise as subdivisions (1) the *moist*, (2) the *moderately moist*, and (3) the *dry* climates, it must be understood that a sharp line cannot be drawn between them, and that some of the places may with equal right be placed under the preceding or the succeeding divisions. Speaking generally, greater moisture is combined with *greater equability* of the chief climatic elements and with a more *sedative*, or, according to circumstances, a *relaxing* character, while dryness of the air renders the latter less equable, more *stimulating*, and often more *invigorating*.

I. Marine Climates with High Degree of Humidity.

Moist climates present great differences, according to temperature, and may therefore be subdivided into (1) warm and (2) cool climates.

1. WARM AND MOIST MARINE CLIMATES.

Of *warm* and *moist* marine climates that of the Island of Madeira is better known than any other, and a good deal has been written about it. Of authors' names we have only to mention Renton, Clark, Mittermaier, Lund, Grabham, and Goldschmidt. The Madeira Islands are situate between 32° and 34° N. lat., and 16° and 17° W. long.; but, in

Madeira.

speaking of Madeira, Funchal, the capital town, is generally understood. The mean winter temperature is as high as 61·2° F.; at night it does not fall below 48°, and in summer the thermometer rarely rises above 80°. The mean daily range is from 7° to 9° F. The humidity of the air is always considerable, but subject to sudden variations under the influence of winds. According to Walshe, steel instruments cannot be kept free from rust, and boots are liable to mould. The rain falls mostly in winter, and the average number of rainy days between November and May amounts to 78. Winds blow tolerably often, and sometimes with great force; from 7 to 9 in the morning, however, there is mostly no wind, whilst from 9 till 4 the sea breeze prevails, and later on in the evening the land breeze blows down the ravines. The wind from E.S.E., being dry and blowing from the Sahara, is much disliked; it is called the 'Leste,' and is rare in the winter proper, but blows in March and April. Whilst it lasts the air is remarkably free from dust and contains a considerable amount of ozone.

The therapeutical character of the climate is *sedative*, and on some persons it has a *relaxing* effect. It is striking how quickly an irritative cough is allayed in most cases, but loss of appetite and tendency to diarrhœa are frequently observed.

Our own experience is limited to 28 cases. Of these, in 3 cases of chronic laryngeal catarrh the results were favourable; of 8 cases with chronic bronchial catarrh 7 were benefited, whilst in one case chronic diarrhœa supervened and produced great weakness of long duration. The remaining 17 were cases of phthisis, 3 in the first stage, with 1 favourable, 1 uncertain, and 1 unfavourable result; 7 in the second stage, with 3 favourable and 4 unfavourable results; 7 in the third stage, 3 of which made some satisfactory progress, in 2 the result was uncertain, and 2 became worse. Of 20 cases sent to Madeira by the Brompton Hospital for Consumption 3 returned improved, 16 had become worse, and 1 died in the island. Drs. C. J. B. and C. T. Williams observed improvement in 53 per cent., no change in 14·28, aggravation of the disease in 34·29, which results were not so good as those attained by them on the Riviera. It is a well-established fact that Madeira has a beneficial effect in chronic catarrh of the larynx and the

bronchi with an irritative cough, also in most cases of emphysema with moderate expectoration, while in phthisis proper its usefulness is more doubtful. There are, however, many cases of phthisis which are suitable for this particular climate, and may be benefited by it to a certain degree, viz. advanced cases with an irritative cough and, generally speaking, those in 'erethic' constitutions. The points to be considered are that sea voyages are well borne, that the patient should not be low-spirited on account of the distance from home, that dry cough or a tendency to bronchitis on each fall of the thermometer are prominent symptoms, that travelling by land does not agree with the patient, that comforts and warmth are a necessity to him, and that subtropical vegetation is likely to have a cheering effect upon his mind, and whether there is any tendency to diarrhœa. In the majority of cases several winters must be spent in Madeira. In such cases the summer may be passed either at a cool and carefully selected place some distance from the island, or at a summer station (*Comacha*) on the island itself, which, though at an elevation of 2,300 feet, cannot be compared with similar stations in the Alps or the Andes, on account of its greater moisture, warmth, and winds.

In addition to Portuguese physicians, there are generally English and German physicians residing in Funchal, and at present these are Drs. Grabham and Goldschmidt.

Canary Islands. Teneriffe.

Much resembling the climate of Madeira is that of the Canary Islands, situated between latitudes 27° 49′ and 29° 46′ N., and between longitudes 13° 2′ and 18° 13′ W., with less rainfall in summer and autumn, but more in winter and spring. It is obvious that, the elevation of the volcanic mountains being considerable, the various local climates of these islands must differ much, according to altitude and aspect. No doubt the Canary Islands, and particularly Teneriffe, offer advantages to invalids similar to those of Madeira, and share in its drawbacks. For certain constitutions and temperaments both equally deserve the praise bestowed upon them by A. von Humboldt. 'No places are more likely to scare away low spirits in a visitor, or give peace to an afflicted mind, than Teneriffe or Madeira.' Out of three cases of chronic catarrh and emphysema, personally known to me, two have

done very well, whilst the third died in consequence of an acute feverish affection. Of four consumptive patients in the first stage, and at the beginning of the second, two improved, and two I have lost, chiefly owing to the appearance of gastric disturbance; two gentlemen suffering from mental depression were much benefited by a residence at Santa Cruz. On the Peak of Teneriffe, Dr. W. Marcet made his interesting observations, throwing light on some doubtful points regarding mountain climates. The best time for Teneriffe is from the end of October to the beginning of May. The accommodation in Santa Cruz is, at the best, but moderate.

The Azores.

The Azores, likewise a group of volcanic islands, situated between latitudes 36° 59′ and 39° 54′ N., and between longitudes 31° 7′ and 25° 1′ W., and belonging to Portugal, are not quite so warm as Madeira, but offer some advantages to invalids. According to the personal reports I had from several gentlemen who had spent some time at Flores, Terceira, Pico, or Santo Miguel, the climate is highly agreeable and had a less relaxing influence on them than that of Madeira, although a tendency to diarrhœa declared itself in one of them. But the want of suitable accommodation [1] will, for some time to come, prevent invalids from using these islands as sanatoria, and the state of ignorance in which the inhabitants are kept, their religious prejudices, and the fear of other views being introduced, will be somewhat in the way of improvements. The best time of the year is the same as for Madeira and Teneriffe.

Ceylon.

The Island of Ceylon, between latitudes 5° 56′ and 9° 5′ N., and between longitudes 80° and 82° E., may be mentioned in this connexion, the western part, from its being exposed to the S.W. Monsoon, having a moist climate, like the coast of Malabar. Some cases have come to our knowledge of subjects with hereditary predisposition to phthisis, but otherwise healthy, who have been living in the island for many years,

[1] According to Dr. J. M. Junkin, who has lately visited these islands, and describes them in the *Phil. Med. and Surg. Rep.*, 1883, we may hope that things have changed for the better. He mentions several good hotels where the English language is spoken, and highly recommends the Azores as a health resort.—*Tr.*

engaged in business, without being attacked by the disease. If phthisis does already exist, the climate is to be avoided.

To the same category belong the Sandwich Islands, between latitudes 18° 5′ and 22° 2′ N., and between longitudes 154° 4′ and 160° 4′ W., the best known of which is Hawaii. On account of the considerable elevation of the volcanic mountains (from 7,000 to 13,000 feet) it seems likely that places suitable for sanatoria will be found on them in the future. The climate of the more inhabited parts is equally warm and moist, but invalids cannot yet be sent there, as no medical aid is available. Some of our informants complained of lassitude, want of appetite, and tendency to diarrhœa.[1]

The Sandwich Islands.

The groups of islands situated to the east of Central America, and comprised under the collective name of the *West Indies* (from 10° to 27° latitude N.), afford great varieties of climate in their different parts. Although, on the whole, they share in the character of hot climates with a variable amount of moisture, they may at times be ranked with the moderately dry. Taking all things together, they must be classed among the warm and moist climates. The seasons are divided as in tropical climates—that is, the four seasons of the temperate zones can scarcely be recognised, but there is a warm or rainy period, comprising July, August, September, and October; November is a transition month corresponding to autumn, and this is succeeded by the cool period, which is also the comparatively dry one, that is, with little rain, but still with a moderate amount of humidity. The latter lasts from December to May, and June is the transition month from the cool to the warm period. This does not hold good for all the islands. In Jamaica, for instance, there are two rainy seasons, the first from May to August and the second during October and November. The conditions of temperature show a good deal of uniformity; the annual mean varies from 75·4° F. in Barbadoes to 80° in Santa Cruz. The mean of all stations in the Antilles is about

[1] A recent article on the Sandwich Islands will be found in the *Phil. Med. Tim.*, Feb. 28, 1880, by C. A. Siegfried. He says: 'A very equable climate, well adapted to patients suffering from diseases of the lungs and circulation, or a tendency thereto, or to a chronic invalid in need of change. Honolulu has a full quota of physicians.'—*Tr.*

78·8°, being for the winter 75° and for summer 83·5°. The daily range in the cool months is on an average 12·5°, and in the warm ones 10° F. The winds blow sometimes violently and tornadoes are not rare.

The Bahamas.

In the group of the Bahama Islands, with a mean winter temperature of between 68° and 71·5° F., winds change frequently, and a tendency to diarrhœa occurs sometimes. A residence in these islands must therefore be recommended only with great discrimination, though, besides the unfavourable results, successes have been recorded, particularly in cases with a tendency to catarrh of the larynx and the bronchi; less so in cases of phthisis.

The Bermudas.

Almost the same remarks apply to the Bermudas, situated somewhat more to the north (lat. 32° N. and long. 64° W.), the climate of which is described as eternal spring.[1]

The Virgin Islands.

The Virgin Islands—St. Croix, St. Thomas, St. John, Virgin Gorda, and Anegada—have a high mean temperature for the winter, ranging from 71·5° to 75° F., with frequently high winds. Gastric disturbances and chronic diarrhœa prevail, and the latter affection may last for a considerable time after cooler regions have been resorted to. They are unsuited to cases of phthisis, but well adapted in some constitutions for catarrh of the larynx and rheumatic states.

Cuba.

Cuba has a mean annual temperature for places near the sea of between 77° and 79° F., the thermometer rarely rising above 86° in summer or falling below 57·2° in winter. In the more elevated places in the interior of the island the temperature is lower by a few degrees. Four cases of apex infiltration without fever, occurring in young clerks temporarily occupied in Havana, gave me an opportunity of studying the effects of the climate. In two of the cases the affection had become arrested after two or three years respectively; in one case it advanced quickly, and one of the patients died in the first year from yellow fever. In another case of

[1] Dr. W. F. Hutchinson (*New York Med. Rec.*, Jan. 3, 1880) points out that the climate of the Bermudas is good, its winter range, however, being a little too low for invalids (60° to 66° F.), while the islands are swept by constant breezes.—*Tr.*

phthisis in the second stage the more chronic form changed into very acute phthisis, by which the patient died in seven weeks. Three cases of chronic catarrh of the larynx and the trachea recovered, whilst a fourth died from fever. In several cases of chronic rheumatism the results were also satisfactory. To sum up, it must be admitted that a stay in Cuba is of doubtful value for consumptive patients, the more so because the dangers of infectious fever have to be taken into account.

Jamaica.

Jamaica, the largest of the English Antilles, is in its lower grounds very hot and not at all salubrious; but in the more elevated regions of the inhabited parts, up to 3,000 and 4,000 feet above the sea, the conditions of warmth and moisture are more favourable and the air is free from malaria. Dr. Theodore Williams records a very favourable case ('Influence of Climate,' 1877, p. 84) in a consumptive young physician, and the author himself has met with a favourable case in the first stage, which is, however, counterbalanced by one with an unfavourable result. On the other hand, a residence at those heights has had a very beneficial effect in two cases of mental excitement caused by business speculations.

Barbadoes.

Barbadoes is less elevated in the interior than Jamaica, but its climate is healthier as regards the lower parts. A residence in this island for the winter has been described by R. H. Bakewell ('Practitioner,' vol. xxi., 1878) as favourable for consumptive patients. The author's experience extends only over four cases in the first stage, and one at the beginning of the second. In two of them the result was favourable, in two the disease advanced, and in one case it remained stationary with improvement of the general health.

We cannot enter into the respective merits of the other islands, particularly as our knowledge of their climates, as far as it goes, does not justify us in recommending any of them more than the islands above described.

Florida.

The climate of the peninsula of Florida, extending from 24° to 31° lat. N. and from 80° to 87° long. W., is similar to the climate of the West Indies. The greater part of it is surrounded by the sea, and it contains many inland lakes. In July, August, and September fevers are prevalent, but they are reported to be rare for the rest of the

year. The peninsula has of late come much in use among North Americans as a winter residence, not only for consumptive invalids, but also for the large class of those requiring warmth.

Georgia. South Carolina.

Georgia and South Carolina are similar, but less warm and more under the influence of the continent.

In the southern hemisphere, where the sea covers a much greater area compared with the land than in the northern, there are several groups of islands with a warm and moist climate, but they are hardly available as climatic health resorts. We cite only a few of them.

Society Islands. Tahiti.

Of the Society Islands, situated in the Pacific and extending from 16° 11′ to 17° 53′ lat. S. and 148° to 151° long. W., we have to consider Tahiti, the largest island of the eastern group, as it may in the future become a resort for invalids of one class or the other. It is described as very beautiful, containing mountains 7,000 feet high and clothed with a tropical vegetation. The mean temperature of the year is about 71° F. In the cool season the thermometer rarely falls below 62·5°, and does not often rise above 79° in the hot season. Hence the climate is very equable and the relative humidity amounts to between 80 and 90 per cent. Several cases have come to our knowledge where resident Europeans became subject to gastric disturbance and persistent diarrhœa. The climate will, therefore, remain unavailable for most cases, although phthisis is said not to occur among the natives.

Tonga or Friendly Isles.

The Tonga or Friendly Isles, extending from 18° to 23° lat. S. and from 173° to 176° long. W., have also a mild, equable, and rather moist, but slightly cooler, climate than the Society Islands. According to the information given to me by a missionary who had resided on Vavao for a considerable time, the general health is moderately good, but a tendency to diarrhœa and loss of appetite are not rare. Scrofulosis and phthisis are not entirely wanting.

Fiji Islands.

The Fiji or Viti Islands, from 15° 3′ to 19° 3′ lat. S. and from 177° to 178° long. W., have similar conditions. The lowest temperature is reported to be 62·5° F., the highest only 97°. The influence of the climate on healthy

visitors is said to be good, though somewhat relaxing. The islands being now British possessions, it is possible that in the future invalids might be sent there.

The group called Tristan d'Acunha, lat. 37° and 38° S. and long. 12° W., has been described as being particularly salubrious. The principal island contains volcanic rocks rising to the height of 5,000 feet. A traveller (Mr. W. C. Carter) has informed me that the climate is moist and equable, but at the same time less hot and relaxing than the climate of the Fiji and Tonga groups, and that by staying on the island for some time he was himself cured of a chronic bronchial catarrh which he had acquired at Melbourne. Hence this is probably a health resort of the future.

Tristan d'Acunha.

St. Helena, belonging to Great Britain, lat. 15° and 16° S., long. 5° and 6° W., has been repeatedly visited by people in quest of health from England and the British colonies. The mean temperature of the year is reported to be 64·5° F., the maximum being about 71·5° and the minimum 58°. The results, so far as I could gather from information, are hardly better as regards phthisis than those gained in Madeira, but in the case of malarious cachexia it has a beneficial influence.

St. Helena.

2. COOL AND MOIST MARINE CLIMATES.

Most of the health resorts of this class lie on the western or north-western coast of Europe, where the air currents passing over the Gulf Stream and blowing from W., S.W., or N.W. arrive on the coast warm and more or less saturated with moisture, precipitating part in the form of rain. Comparatively small variations from one season to another and between day and night, with a cloudy sky and dull air, are the chief characteristics. We shall enter into these conditions more fully in discussing the health resorts of the English coast. Most of the English places might perhaps be classed in the present division, but, from their general effect on the constitution, they must be added to the *moderately moist* climates. We will mention in this connection only some islands on the western coast and in the north of Scotland, as, considering their latitude, they excel by a particularly mild and equable climate.

The island of Bute, with the town of Rothesay, may be taken as the type of these, and is also the most frequented, though almost exclusively by the Scotch. The town offers good hygienic conditions, a low death rate, and good quarters. The island of Bute lies between lats. 55° and 56° N., and between longs. 5° and 6° W., opposite to the mouth of the Firth of Clyde. During nineteen years' observations the thermometer has never risen above 80·5° F. nor fallen below 19·5° (Robert Thom). The mean temperature of the year is 48·2°—for winter 39·3°, spring 46·4°, summer 58·1°, and autumn 48·3° F. The number of rainy days is about 150, and the mean amount of rainfall 40·3 inches. Fogs are comparatively rare.

Island of Bute. Rothesay.

The Hebrides, the Orkney and Shetland Islands, situated N.W. and N.E. of Scotland, have a somewhat colder but otherwise similar climate, being very mild for the high degree of latitude.

Hebrides. Orkney and Shetland Islands.

The same observations might be applied to the Faröe Isles, to Iceland, and to different places on the western coast of Norway, all of which are in their climates more or less influenced by the Gulf Stream.

Faröe Isles. Iceland. Bergen.

The Island of Marstrand, belonging to Sweden, and being much visited not only for its air, but also for the sea bathing, shares to a certain extent in these climatic peculiarities.

Marstrand.

In the southern hemisphere there are different groups of islands offering a cool, moist, and equable climate. They are as yet not available for invalids, or only exceptionally so.

Mention must, however, be made of the Auckland Islands, lat. 50° and 51° S., situated S. of New Zealand, with a mean annual temperature of 52° F., and of the Falkland Islands, with a mean temperature of about 45·3°.

Auckland Islands. Falkland Islands.

II. Marine Climates with Medium Degree of Humidity.

These may be subdivided into (1) warm and (2) cool climates.

1. WARM MARINE CLIMATES OF MEDIUM HUMIDITY.

Mogador.

Of the warm and moderately moist climates one of the most equable is that of Mogador, in Marocco (31° 3′ lat. N. and 9° 47′ long. W.), situated at the north-western extremity of Africa, built on rocks and sand and exposed to the full force of sea breezes. The annual mean of the monthly maxima is 80·5°, that of the minima being 55·7°; the mean temperature for the year 67°, for the hottest month 70°, and for the coldest 58·7° F. The mean relative humidity was in 1874 77·56 per cent., but the average is probably somewhat higher. Mean number of rainy days 44; average of atmospheric pressure 30 inches, minimum 29·5 and maximum 30·4. The sky is nearly always clear. According to Seux, Leared, and Ollive the hygienic condition in the visitors' quarters is good, and phthisis scarcely occurs. The accommodation is as yet limited, but the place is likely to become in time a favourite resort for patients with phthisis and bronchitis, requiring a soft and bright climate.

General character of the Mediterranean climates.

The Mediterranean group is the next that we have to consider, its climates having several points in common. First of all they are *warmer* than places of the same latitude in general. Their ranges of temperature, also, are comparatively small, and the rainfall is peculiar in character, an almost rainless summer being succeeded by abundant rain in the autumn, and also in some places in winter. The greater warmth is chiefly owing to the high temperature of the water of the Mediterranean, this being considerably warmer than the Atlantic, and to protecting mountain ranges. The degree of protection varies according to the position of the mountains, and the amount of rainfall depends on the same conditions. The western portion of the Mediterranean has more of an oceanic character than the eastern. The relative humidity of the air is on the whole low, but differs according to districts. Generally speaking, it decreases from east to west, and is, as a rule, lower on the eastern than on the western coasts. Evaporation is considerable. In all places the conditions of moisture vary according to the different times of the

day, and this is particularly the case in warm and bright weather, sudden changes taking place at the time of sunset, which require the greatest care on the part of invalids.

Only one-half of the Mediterranean resorts is comprised in this group; the other half will be discussed with the dry climates.

Tangiers.

Tangiers, in Marocco, situated at the western entrance of the Straits of Gibraltar (35° 47′ lat. N. and 5° 48′ long. W.), has, according to Leared ('Lancet,' 1873), a mild and tolerably equable climate with moderate humidity. We think, however, that it has more in common with the moist than with the dry group. Very accurate meteorological observations have not yet been published. The heat in summer is not excessive, being moderated by sea breezes, whilst the mountains rising on the south of the town protect it to a great extent from the hot winds of the desert. The mean temperature for the winter is 56·3° F. Rain falls principally in November and December, less in the remaining winter months. Two hotels and a boarding-house afford tolerable accommodation, and the place may be reached from Gibraltar in three hours.

Algiers.

Algiers (lat. 36° 47′ N., long. 3° 4′ E.) is built on the slope of a range of low hills. Invalids avoid the old town on account of its hygienic conditions, and prefer the much healthier surroundings, of which Mustapha Supérieur is the most favourite, having a south-easterly aspect and being sheltered towards the north-west. The mean temperature for the year is about 68° F., that for the winter season (from November to the end of April) being somewhere between 57° and 60°, and the mean diurnal range between 11° and 14°. The annual rainfall amounts to 31·2 inches, half of which falls in winter, the remainder being almost equally distributed over the latter part of autumn and the spring. The number of rainy days is variously estimated at 55 and at 70. The prevailing wind is the north-west, and the Sirocco blows at times, being, however, moderated by the hills situated to the south. The diseases for which the climate of Algiers is suitable are chronic bronchitis, particularly if accompanied by an irritative cough, emphysema, cases of pneumonia and pleurisy

in which complete absorption has not taken place, and early phthisis; cases of diarrhœa and chronic dysentery may also be benefited.

Cadiz. Cadiz, in the Isle of Leon (36° 32′ lat. N., 6° 17′ long. W.), built on a low, chalky, projecting tongue of land, and rising, as it were, out of the sea, although situated on the Atlantic, has a similar climate to that of the Mediterranean places. The mean temperature for the year is 64·4° F. according to Francis ('Change of Climate,' 1853), who has paid a great deal of attention to Spain, that for the winter being 57·3° and for spring 60·8°. The mean daily range is 10·5°. Sea breezes blow on 240 days, which would account for the great equability of the climate and the large number of rainy days, viz. 99, though the rainfall measures only 22·2 inches. The relative humidity in the adjoining San Fernando is given by Hellman as 76° for the year, it being for the winter 82°, for autumn 77°, and for spring 76° F.

San Lucar. San Lucar, at the mouth of the Guadalquivir, is, according to the information I had from Spanish physicians, somewhat warmer and drier, being built on sand, and invalids are frequently sent there from Spain for threatening or incipient phthisis.

Gibraltar. Gibraltar (lat. 36° 6′ N., long. 5° 21′ W.) has the advantage of favourable mean temperatures, that of the year being 62·6° F., of winter 54·5°, and spring 60·5°, while the annual rainfall is estimated at 29·5 inches with 74 rainy days. It can, however, hardly be spoken of as a health resort, the hygienic conditions not being quite satisfactory, apart from the occurrence of a kind of intermittent fever, called 'rock' fever. Medical advice may easily be had, from its being a garrison town.

Ajaccio. Ajaccio, on the island of Corsica, belongs to this group (lat. 41° 55′ N., long. 8° 44′ E.), with a mean temperature for the year of 62·5° F.; winter 52°, spring 60·3°, summer 76·7°, and autumn 66·7°. Rainfall measures 24·8 inches, falling principally in autumn and winter. The humidity of the air is said to be high, but on the other hand there are a great number of clear days. It is almost completely protected from cold winds, and only exposed to the soft south-west wind, this

being the prevailing one. Biermann, having spent several winters there, speaks well of the climate; so do H. Bennett and Rohden, likewise from personal experience, and they think that the place will have a great future as a health resort when the accommodation and the means of communication with the Continent (Marseilles) have been further improved. Our own experience has been favourable in four cases of early phthisis, where the changes were limited to one apex, and in two cases of chronic emphysematous catarrh; unfavourable in a case of chronic pneumonia of the right lower lobe, and in two cases of asthma. Only such invalids should be sent to Ajaccio as are likely to tolerate a moderately moist sea climate. The best time for residence is from the beginning of November to the middle of April. Satisfactory summer stations have not yet been opened in the mountainous part of the island.

The *Sanguinaires*, small rocky islands near Ajaccio, have, according to Biermann, a most favourable climate for the treatment of phthisis, but afford very limited accommodation, and are as yet only used by the inhabitants of Corsica. Biermann thinks that a sanatorium might very well be founded there, with the advantage of a perfect insular climate.

Palermo.

Palermo (38° 7′ latitude N., 13° longitude E.), on the northern coast of Sicily, has an average rainfall of 23·2 inches, distributed chiefly over autumn and winter, with 97 rainy days. The mean temperature is for the year 63·5° F.; for winter 52·56°, spring 59°, summer 75·2°, and autumn 66·2°. The relative humidity for spring and autumn is 73 per cent., for winter 77 per cent. (Tacchini). Fogs do not occur. The vegetation is subtropical, the accommodation satisfactory, and the surroundings are delightful. It is, however, not sheltered from northerly and easterly winds, which are rather cool, and blow violently at times. Another drawback is the long sea journey without which it cannot yet be reached. According to our own experience, and that of others, invalids requiring a good deal of shelter should not go to Palermo. On the other hand, our results have been most satisfactory in chronic and stationary phthisis, and in cases of emphysema with moderate catarrh or co-existing asthma, chiefly in persons for

whom sunshine and picturesque surroundings with their historical reminiscences proved very attractive.

Riviera di Levante.

Among the moderately moist climates of the Mediterranean may be classed some places on the Riviera di Levante, such as Spezia, Chiavari, Rapallo, San Margherita, and Nervi. In all these localities the annual rainfall is greater than in the places on the Riviera di Ponente, and the relative humidity is also somewhat greater, but the conditions of temperature are similar. The mountain ranges situated to the north do not afford complete shelter, owing to their being too low in some places and to there being gaps in them. The sites, also, occupied by the hotels are not always sufficiently near to the protecting mountains, so that cold winds are apt to find access. Nervi offers the greatest advantages among these places, not only as regards shelter but also as to house accommodation and living. Though slightly exposed to winds blowing from the east and south-east, it is completely protected to the north-west, north, and north-east. Another point in its favour is that Dr. Schetelig always resides there, while the advice of Dr. Breiting, of Genoa, may often be had on the spot.

Pegli.

Pegli, situated to the west of Genoa, has a climate very similar to that of Nervi. It is to be regretted that no accurate meteorological details of either of these places have been published. Starke, in criticising the southern winter resorts ('Berliner klinische Wochenschrift,' 1878), draws attention to the superior living met with at the Grand Hôtel de Pegli, a matter of great importance to invalids, and also to the sheltered situation of the place and of the adjoining walks, which are certainly more agreeable than at many other health resorts. The vegetation of the whole neighbourhood points to less dryness of the air. Nowhere else on the Riviera are such fine pine forests met with near the shore, affording shelter from winds and the sun, and one rarely sees at other places such thick tree-like stems of Erica arborea, which here rise to heights of 10 to 13 feet. Although at Pegli and other places on the Gulf of Genoa more rain falls than in the rest of the Riviera, visitors find the air very dry. This is evidenced by the condition of the hair, of wooden objects, and of bread, &c., and by the fact that the cedar of Lebanon, which requires moisture,

hardly ever thrives, and that the only fine specimen kept in the Pallavicini gardens perished lately. In several cases of chronic laryngeal catarrh we have seen good results, also in two cases of emphysema with tendency to bronchitis, and in several cases of chronic rheumatism and mental depression. The limited social resources are an advantage for some of these cases.

Venice (latitude 45° N., longitude 12° E.) differs considerably from the localities described just now, but was formerly a favourite resort for chest patients. According to the 'Meteorologia Italiana' the mean temperatures for the year are 56·8° F.; for winter 39·43°, spring 55·83°, summer 74·16°, autumn 57·47°. The rainfall measures 35·2 inches. The average humidity is, according to Joseph, 87 per cent. The mean difference between the maximum and minimum temperatures amounts to 21·6° F. for the winter, and ranges from 25·2° to 27° in the other seasons. The shelter to the N., N.E., and N.W. afforded by the Alps and outlying mountains is not complete. The limited space impresses many invalids with the feeling of monotony, and induces them to visit churches, galleries, and narrow canals which are frequently sunless and exhale vapours. On the other hand, the absence of dust and of malaria, the stillness, and good living are great advantages. The hotels and private houses situated in the Piazza of St. Mark and on the Grand Canal are nearest to the walks and enjoy much sunshine.

Venice.

We have seen several good results in cases of laryngeal catarrh and of chronic, stationary phthisis with irritative cough, also in sleeplessness from an excited nervous system, but cases of chronic catarrh, with abundant secretion, and rheumatic patients did not do well.

For a certain class of invalids, requiring less strict supervision and nursing, different places may be pointed out situated on the western coast of the Balkan Peninsula, or on one of the islands belonging to it—for instance, the Austrian islands Lissa and Lesina, the Ionian islands Corfu and Zante, and Patras (Patrae), on the gulf of the same name. However, the sanitary state of these places is far from perfection, so that their climates can be used only with the greatest care.

Balkan Peninsula: Lissa, Lesina, Corfu, Zante, Patras.

The Crimea, Cyprus, and the coast of Asia Minor also afford some places which may be employed at some future date for the treatment of invalids, when their hygienic condition and the accommodation have been improved.

Crimea.

Lisbon, on the western or Atlantic coast of Portugal (latitude 38° N., longitude 9° 8′ W.), was once famous as a winter resort, but has been all but forgotten as such, although it seems not inferior to other and still frequented health resorts. The mean temperature of the year is 60° F.; of winter 51°, spring 58°, summer 69·5°, and autumn 62·2°. The relative humidity is 71 per cent. Rain falls to the amount of 29·35 inches annually, and the number of rainy days is 112. Living and house accommodation are good, but there are sudden changes from damp to dry, and from cold to warm weather, and winds blow sometimes with great violence. Invalids requiring care should, therefore, not be sent there, particularly as the social intercourse and the attractive surroundings are apt to tempt them to be indiscreet.

Lisbon.

The Iberian Peninsula on its western and northern coast affords several other places which are more attractive by beauties of nature than by their climates, such as Vigo, Corunna, Ferrol, Santander, San Sebastian, Portugalete. All of them are under the equalising influence of the Atlantic, the gulf on which they are situated modifying their climates. They attract visitors from the adjoining countries, particularly on account of the sea bathing, but their advantages are not sufficiently great to justify our going into a more detailed description.

Vigo, Corunna, Ferrol, Santander, San Sebastian, Portugalete.

Of more general importance is Biarritz (latitude 43° N.), on the Bay of Biscay, near Bayonne. The autumn, winter, and spring are mild, although, owing to its situation on the stormy Atlantic bay, violent winds blow sometimes. The mean winter temperature is from 43° to 46·5° F., that of spring being 52° to 53·5°, and of summer about 64·5°. The relative humidity is about 80 per cent. and the rainfall measures 49·25 inches. The soil is dry and sandy. Accommodation and living are excellent in the Hôtel d'Angleterre. Medical advice may be had from French and English physicians. Although Biarritz is chiefly resorted to by the French and Spaniards for

Biarritz.

the sake of a change and for sea bathing in summer, we can, having regard to its climate, recommend it also as an autumn station.

Arcachon. Arcachon (latitude 44° 7′ N.) is situated on a kind of half-inland bay, being open to the north but surrounded in every other direction by sandhills covered with extensive pine forests. It enjoys equability of temperature with a certain degree of humidity, and the châlets erected for the reception of invalids and forming the so called winter town lie in the midst of the pine forest, being well sheltered from winds and getting all the advantages of the resinous emanations of the pine trees. Bournemouth, on the south coast of England, is the only winter resort with which Arcachon can be compared; but as to the former, the pine forests at Bournemouth have been considerably cleared, and they do not extend so far inland. According to Hameau the mean temperature is, for the year 58° F.; for the winter 44·5°, spring 64·2°, summer 68°, and autumn 58·8°. The average humidity is 85 per cent., and the rainfall measures about 34·8 inches with 103 rainy days. The amount of ozone in the air is considerable.

According to Dr. Hameau's experience and to an account given by the Rev. Samuel Radcliff, who himself suffered from an affection of the chest, the place suits consumptive invalids of an erethic constitution, and cases of laryngeal catarrh and many forms of asthma, but it is not suitable to people with a torpid constitution or with a weak heart.

New Zealand. Several other places in the northern and southern hemisphere might be enumerated in this subdivision as being adapted for the climatic treatment of invalids, but we must restrict ourselves to a short account of New Zealand, which now already offers important places, and will probably possess more of them in the future. As the three islands extend from lats. 34° to 47° S. their climates must afford considerable varieties, not only according to the different degrees of latitude, but also as to the situation of individual places on the eastern and on the western side of the islands respectively. Owing to the chain of high mountains traversing each of the islands (particularly North Island or New Ulster) another element is added which increases the climatic differences.

North Island, the adjoining part of South Island, and New Munster, with the seaport of Nelson on its northern extremity, appear to have the best climates.

According to Dove's tables the mean temperature of Auckland (lat. 36° N., long. 174° E.), situated on the western

Auckland.

coast of New Ulster, is for the year about 59° F.; for winter 50·9°, spring 57°, summer 66·2°, and autumn 60·8°.

New Plymouth, also on the western coast, and Wellington, on the southern extremity of New Ulster, have similar condi-

New Plymouth. Wellington. Nelson.

tions of temperature, but in Nelson the winter temperature is only about 43·9° F., that of the autumn being 54·7°. The difference between the warmest and coldest month shows the low figure of from 16° to 18° F., being much less than on the Riviera; and some authors speak highly of the climate of North Island, commending it particularly for persons with a tendency to phthisis or in the incipient stages of the disease, whereas the climate of parts of South Island and that of Steward Island is reported to be changeable and exposed to winds. A drawback is the occasional occurrence of great and sudden changes in temperature and humidity.

Dr. A. S. Thompson, in a table on the meteorological conditions of Auckland for the year 1849, gives 179 as the number of rainy days, and the amount of rainfall at about 55·2 inches. In Wellington, according to Dieffenbach, 38·5 inches of rain fell from April 1841 to February 1842. Winter there is the comparatively rainless time. The soil is of a volcanic nature. Phthisis is reported to be very rare among the colonists, but of frequent occurrence among the natives, and the same may be said of rheumatic and scrofulous affections. This is accounted for by the bad hygienic habits and dwellings, and the diet being chiefly limited to potatoes.

2. COOL MARINE CLIMATES OF MEDIUM HUMIDITY.

Characteristics of the coasts of England and Ireland.

Of climates belonging to this group those of the coasts of England and Ireland occupy the most prominent place. Attention has been drawn to them in German medical literature by the valuable articles

of Beneke ('Berlin. klinische Wochenschrift,' 1872) and of Rohden ('Archiv für Heilkunde,' xiv.), both authors writing from personal observation. Although great differences exist between different regions, particularly as to whether situated on the west and south-west coasts or on the south-east and east coasts, and also as to local conditions—for instance, whether they are under the shelter of mountains or situated in an exposed position on the top of a cliff—still there are certain general features common to all of them, and these we shall now consider.

First of all we have to bear in mind that the British Isles, like the north-east coast of France, are under the influence of the Gulf Stream. In discussing the influence of ocean currents in our general remarks we have drawn attention to this fact, and for a clear exposition of the subject we refer the reader to Buchan's meteorological works and to a popular article on the Gulf Stream written by Carpenter in 'Good Words,' 1873. It is shown by these authors that the winter temperature is remarkably increased, and the heat in summer lessened, so that the isotherms from 37° to 45° F. for the winter months ascend in an almost vertical line from south to north. In accordance with the fact that in winter the sea in the south-west of England is considerably warmer than in the more eastern parts of the English Channel (measuring 46° F. near the Scilly Islands, compared with 39·5° at Eastbourne), the south-west coast of England—that is, the coast of Cornwall and Devon—has a higher average temperature than the south-east coast, as is shown by comparing Torquay or Sidmouth with St. Leonards.

The air having been previously warmed and loaded with moisture by the Gulf Stream, on reaching the British coast comes in contact with colder currents, and must obviously condense into mist and rain. Hence arises an excess of rainfall at different places and in different years, amounting to between 23·7 and 55·2 inches, while the number of rainy days may be stated to be between 130 and 200. Generally speaking, the amount of rain and the number of rainy days is greater on the west than on the east coast, because in the case of the former the warm and moist current of air encounters ranges of mountains and

hills. The atmosphere, when loaded with vapour, does not merely produce excessive rain, but also hides the sun, and thus intercepts both heat and light. The black bulb thermometer shows that the heat from the direct rays of the sun in winter averages 27°, 36°, or even 45° less in England than in the High Alps (Dr. Frankland) and on the Riviera (Dr. Marcet), the comparatively dry atmosphere of the latter regions allowing a great part of the heat from the sun's rays to pass to the earth, whilst the moist atmosphere of England absorbs most of the heat. On the other hand, as Tyndall has well shown, this moist atmosphere obstructs the nightly radiation of heat, so that the evening and night temperatures do not differ so much from that of the day as in the case of the dry southern stations. For the same reason moisture is not deposited at sunset so copiously as at many places in the drier and clearer south, and weakly persons do not run so much risk in being out of doors at that time of the day, particularly if the sky be overcast.

As regards rainfall, there is another difference between this climate and subtropic climates in the fact that in England rain falls pretty equally at all times of the year, and that there is not any decidedly dry or decidedly wet season, although the quantity of rain and the number of rainy days is slightly in excess during the months of autumn and winter compared with spring and summer. The annual rainfall on the English coast is also distributed over a larger number of days than, for instance, on the Riviera, even though the amount be the same. Hence, according to the observations of Dr. Falls and others, the yearly rainfall at Bournemouth averages about 28·8 inches; and Dr. Hill Hassall, from records at the San Remo observatory, reports almost the same rainfall at San Remo; but the number of rainy days in Bournemouth averages from 120 to 160, whilst at San Remo it is only 48.

Another point of equal importance is that on the English coast on most rainy days the downfall is distributed over many hours, during which rain falls continually in mere drops, as it were, the sky being at the same time overcast and not clearing up even during the rainless hours of such rainy days; while on the Riviera, and at many other subtropical places, the whole amount of rain comes down in the course of a few hours, and

then the sky clears up. Dr. Hill Hassall, from records at the observatory, has estimated the number of rainy hours in San Remo at 195·6 for the whole year. Accurate records not being available, we could not estimate the amount of rainy hours for the English coast, but five or six times the number might be near the truth. Owing to the mode of rainfall alluded to, the soil absorbs the moisture and yields it up gradually by evaporation, giving rise to a luxuriant vegetation in England as compared with the Riviera, but at the same time being another source of atmospheric moisture or the saturation of the air with humidity. The *comparative humidity* is, in fact, rather high, and averages for the year and for different regions from 80 to 86 per cent., being as a rule slightly lower in summer and conversely higher in winter.

As regards temperature, it varies according to the locality from 46·5° to 52° F., being for the winter months at sheltered places 41° to 44·5°, and at places not sheltered 39° to 41°; for spring 44·5° to 50°, summer 60° to 62·5°, and for the autumn 50° to 52·7°. Compared with inland places the coast line is warmer in winter and cooler in summer. Thus, to take one example, the mean winter temperature of Torquay exceeds that of London by 3·6°, but the summer temperature is lower by 2·5°, the mean annual temperature being about the same for both places (slightly above 50° F.) The barometrical pressure is on an average 29·98 inches, but there are great differences between the maxima and minima, and the periodical variations are considerable. The prevailing winds are those from the west, south-west, and south, these being considerably more frequent than the winds proceeding from all other quarters taken together; in spring, however (March to April), easterly winds predominate. As mentioned above, the sun has less power than in the southerly places, and clear sunshine is of rarer occurrence. We have also to consider that in higher latitudes the days are shorter in winter than in lower latitudes, the sun being above the horizon for a shorter space of time.

On the other hand, we must bear in mind that the sanitary conditions are, on the whole, very much better in English resorts than anywhere else. The educated classes of the population are well aware as to the importance of these conditions

and the press, both medical and general, is on the alert in calling attention to defects, thus either enforcing improvements or keeping the public away from the health resorts. The yearly mortality is lower in the places under consideration than in most of the other European or non-European health resorts, and averages from 15 to 20 per thousand, the latter number being rarely exceeded. This points to a vigorous state of the population, and to a certain limitation, though not entire absence, of the preventible causes of death, particularly zymotic disease. The food is nourishing, although for some foreigners too substantial and not varied enough. The accommodation is good at most places, both in hotels and private houses, and the plague caused by insects is but rarely met with. Dust, a source of much annoyance at many places in the south, is here all but absent. As regards cost of living, which will have to be considered by many, English health resorts used to be much more expensive than places in the south of Europe. Of late, however, prices have risen so much in the latter that at some places—for instance, in Cannes—living is dearer than in England; at any rate, the difference between the two is no longer so great as it used to be. Good medical advice may be had almost everywhere, but the customary fees are higher than in other parts of Europe. The social life of the valetudinarian may be called rather monotonous compared with the life in Southern Europe; the inhabitants are graver in their manners, their dress is less picturesque, and the vivacity and ready wit of the southerners are absent. These circumstances, together with the dulness of the sky, have a depressing effect on many persons. Frequently we begin the day with the sense of having to fight against depressing influences; those, however, who can overcome these, and take a reasonable amount of exercise in the open air in spite of a disinclination to do so, and can also enjoy the plain but wholesome food, generally become more hardened and robust than in southerly places, which are more cheerful as to climate and social intercourse. On the whole we might say of English resorts that the climate is healthy and invigorating, though not agreeable, and that to a certain extent it requires powers of resistance.

The climatic characteristics of the English seaside places

may thus be summarised: Greater warmth than is due to latitude; equability of temperature as regards different seasons and times of day; a comparatively high amount of humidity; a dull atmosphere with little sunshine; and very favourable hygienic and dietetic conditions.

Summary as to climate.

Cases requiring warm and dry air are less suitable for the English coast than for the Mediterranean, such as cases of gout and rheumatism, chronic albuminuria, some forms of emphysema, of chronic bronchitis, asthma, dyspepsia, and of diabetes; and the same applies to persons of a permanently weak constitution, and to old or prematurely aged people. On the other hand, the English sea coast might very well be recommended in many cases of weakness owing to acute disease or overwork, in scrofulous affections, in retarded convalescence from acute diseases, and in many forms of phthisis.

Therapeutic applications.

Comparatively few of the places are so sheltered from winds that they can, in a general way, be spoken of as winter health resorts; whilst the number of those exposed more or less to all winds, and suitable for a stay in summer, is much larger. In subdividing the different places into winter and summer health resorts, we must mention that the winter resorts are for many cases also suitable in summer, and that the summer resorts may be used during the greater part of the year by those persons who do not require much shelter.

(*a*) WINTER HEALTH RESORTS.

Queenstown or Cove, in Cork Harbour, Ireland, has a sheltered position and a very mild and equable climate. According to Scott its average temperature is for the year 60° F.; for winter 44·2°, spring 50·2°, and autumn 60°: annual amount of rainfall between 31·5 and 35·5 inches, distributed over about 121 days: mean relative humidity from 75·3 per cent. in spring to 89·2 in winter. Ireland is commonly considered a damp country, but the above figures do not denote a greater proportion of humidity than is met with at most resorts on the English coast. The number of rainy days, however, is probably mostly higher than that given by Scott.

Queenstown.

Penzance, situated nearly at the extreme western point of the county of Cornwall (lat. 50° 7′ N., long. 5° 31′ W.), on the north-west portion of Mounts Bay, is but slightly protected from winds. The mean annual temperature is 51·8° F., being for the winter 44°, for spring 49·6°, summer 60·6°, and autumn 52°. The difference between the maxima and minima in winter rarely exceeds 27°—in spring 33·3, summer 27°, and in autumn 64°. Rains falls on 178 days, which are distributed as follows: in winter 50, spring 40, summer 39, and in autumn 48. The annual rainfall measures about 44·5 inches. The most prominent feature of the climate is the slight difference between the temperature of the day and that of the night, rarely exceeding 3·6° when the south-west wind blows; and between summer and winter (16·6°). Although the mean annual temperature at Penzance is only 1½° higher than in London, it is nearly 5° warmer in winter and 2° colder in summer. The difference between the mean temperature of the warmest and coldest months in London is 26°, while at Penzance it is only 18° F. The south-west is the prevailing wind during the greater part of the year; but in spring winds from the east blow frequently, Penzance being much exposed to them, owing to its situation.

Penzance.

The climate of the Scilly Isles is similar to that of Penzance. They are situated to the south-west of Land's End, between lats. 49° and 50° N. and longs. 5° 6′ and 7° W., and consist chiefly of granite. Compared with Penzance, they are slightly warmer in winter, and their climate is even more equable, the amount of relative humidity being 89°. Strong winds prevail frequently.

Scilly Isles.

The climates under the three last headings are to be recommended in cases in which there is a tendency to bronchitis with scanty sputa and irritative cough, but they are not suited for phthisical patients.

Torquay, on the south coast of Devon, has quite similar meteorological conditions to those given for Queenstown. The annual rainfall exceeds 39 inches, the number of rainy days being from 160 to 180. Torquay is well protected from winds and is most beautifully situated. The houses are either built along the shore or on the hills surrounding the bay.

Torquay.

There is abundant opportunity for exercise either on level or gently rising ground. Fogs are less frequent than in most other places of England. Of 14 cases of phthisis in the first and second stage we have recorded improvement in 6, no decided change took place in 5, and the symptoms were aggravated in 3. Of 3 cases of chronic pneumonia of the lower lobe 2 showed considerable improvement; and the same occurred in 2 cases of chronic pleuritic effusion. Drs. C. J. B. and C. T. Williams observed improvement in 60 per cent. of their phthisical patients, while 10 per cent. remained stationary and 30 per cent. became worse.

Chronic rheumatic and gouty states are less suited for the climate of Torquay, and the same may be said of atonic catarrh of the stomach or of the bronchi. The work of the late Dr. Radcliff Hall contains much information on Torquay, and we are personally indebted for valuable hints to the resident physicians Dr. Dalby and Dr. Huxley.

Teignmouth.

Teignmouth is also moderately protected, but does not afford so much accommodation as Torquay, and has not as yet gained a prominent position as a winter station, although, according to Dr. Lake's observations, the meteorological conditions are favourable.

Salcombe, Dawlish, Budleigh-Salterton.

Salcombe, Dawlish, and Budleigh-Salterton, all of them on the coast of Devon, are well protected from cold winds, and their vegetation points to a very favourable climate. On the other hand, there is not much opportunity for exercise, and but little has as yet been done to make these places attractive for invalids.

Exmouth.

Part of Exmouth stands high and is exposed to winds; the lower parts of the town are protected from these, but have the disadvantage of proximity to the river.

Sidmouth.

Sidmouth, according to Dr. J. J. Mackenzie's observations, enjoys the same advantages as Torquay. It is quite as much sheltered by hills, being in fact almost solely exposed to the south. Notwithstanding these advantages, the place is as yet not much frequented. We have seen good results in several cases of phthisis in the second stage, attended with irritative cough.

Bournemouth, on the coast of Hampshire, has become in

the comparatively short time of thirty years one of the most frequented among the milder climatic resorts of England.

Bournemouth. It is situated in a bay open to the south-west, but protected from north-west, north, and north-east winds. The sand hills in the form of a semicircle descend rather abruptly to the shore, and are at most places covered with pine trees, and many of the residences are situate in the midst of these pine woods, as at Arcachon. The sandy soil, being very dry, absorbs moisture so quickly that exercise in the open air is possible even immediately after a heavy fall of rain. Hence the air appears to be drier and at the same time clearer than at most of the other places with a similar climate. The cold east and north-east winds of spring are unpleasantly felt even here, but the East Cliff affords some shelter, which is increased by the fir trees. The meteorological observations published by Dr. Falls and Dr. Compton show the conditions for Bournemouth to be as favourable as for any other place on the coast. The mean annual rainfall exceeds 31·5 inches, the number of rainy days being from 120 to 160; the annual mean of relative humidity ranges between 75 and 86 per cent., the mean of the driest months (May to August) being rarely under 70, and that of the rainy season (November to January) rarely reaching 89 per cent. According to Dr. Compton's tables, comparing the lowest temperatures experienced at Bournemouth and 45 other English stations during the great cold of December 1878, Bournemouth was the second warmest (20·7° F.), Ventnor occupying the first place; that is to say, the readings at every other place were lower than at Ventnor and Bournemouth. The results obtained at the sanatorium for chest diseases in Bournemouth are on the whole satisfactory, but, as is the case in such institutions, the patients are generally discharged too soon.

My own experience may be summed up as follows:—In 3 cases of catarrh confined to the apices of the lungs and occurring in persons without hereditary predisposition, a residence lasting from 6 to 8 months was attended with good results, both locally and as regards increase in weight and strength; in 6 cases of a similar nature, but without hereditary predisposition, 3 improved considerably, 1 remained

stationary, and in 2 the disease advanced; of 3 patients with phthisis in the second stage, 1 (not hereditarily predisposed) improved, in 1 the disease remained stationary, and in 1 it advanced, pronounced hereditary predisposition being present in the last case. Of 3 cases with pleuritic effusion 2 did very well, whilst the third patient was phthisical and died soon afterwards in London. In several cases of chronic bronchitis, and in others where complete resolution had not taken place after croupous pneumonia, the recovery was most satisfactory. In several cases of asthma, with tendency to neuralgia, Bournemouth did not suit, while livelier places, such as Brighton, Folkestone, and Ramsgate, produced decidedly good effects; and the same I found in cases of debility with anæmia, loss of appetite, and scanty menstruation.

Drs. C. J. B. and C. T. Williams recorded improvement in 65 per cent. of their consumptive patients, in 10 per cent. the disease remained stationary, and 25 per cent. became worse.

Isle of Wight. The Undercliff.

The Undercliff, with Ventnor and Bonchurch, in the Isle of Wight, had a more than European fame 40 or 50 years ago, chiefly owing to the favourable comments of Sir James Clark. Although somewhat neglected at a later period, they have lately again come into prominence by the good results attained in the hospital for consumptive patients founded by Dr. Hill Hassall. The narrow, terrace-like Undercliff, formed by a landslip and consisting of chalk, rises to a height of from 100 to 150 feet above the sea, being almost completely protected from the cold north-west, north, and north-east winds by chalky hills, 400 to 500 feet high. The shelter from the east and west is tolerably good, but the sea breezes from the south-east, south, and south-west have free access. The surroundings are picturesque and offer many opportunities for walking and carriage exercise, whilst the sky is as clear as anywhere else in England. Fogs are not frequent, either in the autumn, winter, or spring. Formerly the mean temperature of Ventnor was commonly considered to be lower than that of Torquay, but later observations show it to be slightly higher (Dr. Hill Hassall and Dr. Coghill); the mean daily range for the winter months is given by Tripe ('Quarterly Journal of the Meteorological Soc.,' April 1878) as only 8°, and the mean monthly as 25·2° F.,

showing the climate to be very equable. The mean rainfall for the winter months (November to March) is about 15 inches, distributed over 83 days.

As regards the results of the treatment of disease by the climate of Ventnor, the following is a summary of our cases: Of 6 cases of phthisis in the first stage, without hereditary predisposition, 3 were cured, 1 improved considerably, another slightly, and 1 became worse; of 4 hereditary cases in the first stage 2 improved, 1 remained stationary, and in 1 the disease advanced; of 4 non-hereditary cases in the second stage 2 improved, 1 remained stationary, 1 became worse; of 5 hereditary cases in the second stage 2 improved, and in 3 the disease advanced. Of Theodore Williams' cases nearly 69 per cent. improved, $6\frac{3}{4}$ per cent. remained stationary, and 24 per cent. became worse. Rohden has given a good description of the excellently arranged hospital for consumption; the results gained at this institution have been most favourable under its founder, Dr. Hill Hassall, and have remained so under Dr. Coghill, the present physician. We have frequently had occasion to observe good results, but we cannot quote detailed statistics; it is only to be regretted that most patients cannot be kept long enough, on account of the great demand for admittance. Dr. Coghill recommends Ventnor also in chronic bronchitis, in different forms of asthma, particularly the catarrhal, in cases of neuralgia and of malarious cachexia, and especially in all forms of scrofula.

Bonchurch.

Bonchurch, situated close to Ventnor, possesses a variety of fine villa residences and a good hotel. Its climate is almost identical with that of Ventnor.

Hastings. St. Leonards-on-Sea.

Farther to the east, in Sussex, on the south-east coast of England, we have in Hastings, and its continuation St. Leonards-on-Sea, health resorts of old fame, but which have slightly lost in reputation as to the treatment of phthisis. These two places extend along the coast for 3 or 4 miles, and are protected in a considerable degree from northerly and also from north-west and north-east-north winds by hills ranging from 600 to 700 feet in height; Hastings, the more easterly of the two, affords also slight shelter from east winds; but both places are fully exposed to the south-east,

south, and west. There are level walks along the shore, and the old road to London, rising gradually and following a northerly direction, also affords a sheltered walk which is of advantage to invalids, especially during the prevalence of strong sea breezes. The soil is dry, owing to a thick layer of gravel. Hastings has an advantage over most other seaside places owing to the seats erected on the Parade and affording shelter from winds. The mean annual temperature is given by Sir James Clark as 50·4° F. According to Dr. Tripe, the mean temperature of the winter months (November to March) in the years 1874–77 was 41·2° F.; of December (the coldest month) 39·7°; mean maxima 45·4°; mean minima 37·3°; mean daily range 8·1°; mean monthly range 27·8°. During these 5 months the mean number of days in which northerly or easterly winds prevail is given by the same observer as 63, leaving 87 in which they are either southerly or westerly, whilst the average number of rainy days is 90. The mean rainfall is slightly in excess of that at Ventnor. Hastings is decidedly less protected than the health resorts situated on the south coast of Devonshire, and should not be recommended indiscriminately to delicate persons, particularly in spring, when easterly and southeasterly winds prevail. However, if invalids use care and judgment, the results in cases of phthisis are not unfavourable. The author's own experience has been that in 10 cases in the first stage 5 gave favourable, 3 doubtful, and 2 unfavourable results; in 11 cases in the second stage 5 did well, 2 returned neither better nor worse, and 4 became worse. Williams records even better results, for of his cases 72 per cent. improved, 5·2 remained stationary, and only 22·8 became worse.

Autumn and winter are the best seasons for Hastings, while during the spring months the more westerly and better protected places are to be preferred.

As regards the west coast of England, some places in Wales might be cited as affording moderate shelter in winter, and, on the north coast of Wales, Llandudno has lately come into some favour as a winter station. The mean temperature for the winter season (November to March) is 43·7° F., being 2·5° in excess of that of Hastings; the daily and monthly ranges are somewhat higher; the mean humidity

Llandudno.

is about the same. There are good opportunities for exercise, and the accommodation is excellent.

Grange. Grange, a beautiful and well-protected spot on Morecambe Bay, in Lancashire, on the west coast of England (lat. 54° N.), is as yet but little known. In winter it is by some degrees warmer than more southerly places in the interior of England, and the fact that myrtles and other southerly shrubs flourish in the open air points to the existence of a local climate due to the shelter from the chalk cliffs and the influence of the bay. This 'northern Riviera on a small scale' possesses a good hotel, affording accommodation at all times of the year, and has of late been used as a winter residence by people in the north of England. On account of the low situation of the village, however, the climate is of relaxing character for many invalids, and the results of treatment here are doubtful; but the villas built on higher ground do not share so much in these drawbacks.

We must refrain from discussing the differences of the various localities mentioned, as regards the special indications afforded by their climates; but quite in general, and following the example of Clark, Walshe, Williams, and others, a division of the English coast climates may be attempted into the more *bracing* and the more *relaxing*, the easterly places belonging as a rule to the former and the westerly (especially the south-westerly) forming part of the latter class. Amongst what may be called winter health resorts the following may be grouped under the relaxing class: Queenstown, the Channel Islands, Penzance, Scilly, Torquay, Teignmouth, Salcombe, Dawlish, Budleigh-Salterton, Exmouth, Sidmouth, and Grange; under the more bracing, Hastings and St. Leonards-on-Sea; whilst Bournemouth, the Undercliff, and Llandudno occupy a somewhat intermediate position, being, however, more related to the bracing group.

(*b*) SUMMER HEALTH RESORTS.

The sea coasts of England, Scotland, and Ireland abound in places suitable as summer residences for many classes of invalids, whether bathing forms part of the treatment or not.

We cannot enter into a full description of the various localities, but shall only group the principal places according to their peculiarities. The places on the east coast are the most stimulating, being comparatively dry and exposed chiefly to winds blowing from the east and north-east. Their mean temperatures being low, they are suitable especially for summer and the beginning of autumn. Among these may be mentioned Nairn and North Berwick, in Scotland; Tynemouth, in Northumberland; Whitby, Scarborough, Filey, and Bridlington, in Yorkshire; Cromer, Yarmouth, and Lowestoft, in Norfolk; Westgate, Margate, and Ramsgate, in Kent. On the south-eastern coast there are Dover and Folkestone, both of which may still be called bracing places, although, owing to the Downs rising to a height of 500 or 700 feet, they are to a certain extent protected from northerly winds, and are consequently warmer in summer. Folkestone has of late come much into favour, and occupies a prominent place by its double climate—the more sheltered sea shore and the open west cliff with a less pronounced sea climate. On the coast of Sussex and to the west of St. Leonards-on-Sea we have Eastbourne, also a quickly rising place, and farther west follows Brighton, in a certain sense the seaside suburb of London. The climate of Brighton is very invigorating, but the large extent of the town is a drawback, a certain amount of smoke hanging over the walks along the shore when light winds are blowing from the land. Brighton is comparatively little visited in the summer, its chief season being from October to December, when it has the advantage over the interior of a drier and warmer atmosphere, which is almost free from fogs, and when it attracts many of the well-to-do English. The eastern portion of the town affords a walk which is almost completely sheltered from northerly winds, so that Brighton in the autumn season is also adapted to such pulmonary cases in which only a moderate amount of shelter is required. The bracing character of the Brighton climate is shared to some extent by several places situated to the west of it, such as Worthing, Little Hampton, and Bognor.

Of the cases which may be sent with advantage to these places we mention those of general debility of the system,

more especially if produced by weakening discharges, sedentary habits, or deficient respiration; also cases of anæmia, amenorrhœa, and where there is a tendency to take cold. An additional advantage is afforded by the ample accommodation for sea bathing, and, in some places, for warm sea-water baths and tepid swimming baths filled with sea water.

The places situated farther westwards have, on the whole, a less bracing climate in summer, except where particular conditions exert their influence. This applies to Freshwater and Alum Bay, situate on the north-western extremity of the Isle of Wight, and exposed to the full influence of the Atlantic; and this is also the case to a less degree with Shanklin, Sandown, and Seaview, on the same island, with an easterly aspect.

As regards the south coast of Hampshire, Devonshire, and Cornwall, the most frequented places have been enumerated among the 'winter resorts.'

North coast of Cornwall and Devonshire. Wales.

The north coast of Cornwall has a more invigorating influence than the south coast, and is moister and more equable than the places situated on the east coast of England; the same applies to the north coast of Devonshire and to the northern and western coast of Wales. As to Cornwall, we may mention New Quay, a rising place, situated on Watergate Bay; in Devonshire, Ilfracombe, Lynton, and Lynmouth are to be recommended; on the coast of the Bristol Channel, Weston-super-Mare and Clevedon; on the west coast of Wales, Tenby and Aberystwith; on the north coast of Wales, Penmaen Mawr, Llandudno, Rhyl, Abergele, Aber, and Beaumaris. Farther northward, on the west coast of England, there are St. Bees, Silloth, and the Isle of Man; and, yet more to the north, the islands on the west coast of Scotland.

Ireland.

The coast of Ireland offers, likewise, excellent resorts for the summer, such as Bray, near Dublin, and, farther north, Duncannon, Tramor, Rostrevor, and Portrush. In the north-west, on the Donegal Bay, Bundoran is much liked. The west and south-west coasts have the advantages and disadvantages of the direct influence of the Atlantic.

The climate of the north-west coast of *France*, particularly of the Département de Finistère, is in many respects similar to

that of the south-west coast of England, both coasts being under the influence of the Atlantic Ocean, and more especially of the Gulf Stream. On the other hand it is obvious that, when the wind blows off the land, the air must be much drier, owing to its passing over a large tract of continent.

If we describe in some detail the climatic conditions of a well-known place belonging to this region, some idea can at the same time be formed as to various other localities of a more limited repute.

Brest.

Brest has lately been well described in a monograph by Dr. Borius (Paris, 1879), entering fully into its meteorology and hygiene. The mean annual temperature resulting from 10 years' observations is 53° F., that for the winter being 44·2°, for spring 51·2°, summer 62·8°, and autumn 53·8°. Rain falls on about 175 days during the year, and the average amount of it measures 29·75 inches. As to moisture, the following figures are given :—

	For the Year	Winter	Spring	Summer	Autumn
Vapour tension (inches) .	0·354	0·267	0·313	0·453	0·361
Relative humidity . .	79	85	75	74	81

The winds blowing from the south-west and west are the most frequent, being Atlantic in character; the Continental winds from the north-east and east come next in frequency. The mortality is about 32 per 1,000, whereas that of the whole of France is only 23·2, according to Bertillon ('Démographie de la France,' 1874); the comparatively high figure given for Brest loses something of its significance owing to the fact, that the number of births being very high, the mortality among children increases accordingly.

On the north coast of France there are a number of places which are much frequented in summer and the beginning of autumn, and offer many social attractions.

North coast of France. Belgium. Holland. Germany.

Compared with Brest the climate is less equable as regards temperature during the day and the seasons, but is, at the same time, drier and more stimulating. Such places are Dinard, Villers-sur-mer, Deauville, Trouville, Havre, Etretat, Fécamp, Dieppe, Boulogne, Calais; on the Belgian coast, Blankenberghe and Ostend; on the Dutch, Scheveningen; on the German, the islands of Borkum, Norderney

Baltrum, Langeroog, Spikeroog, Wangeroog; also Dangast and Cuxhaven; Wyk, on the Island of Föhr, and Westerland, on Sylt. The seaside places on the Baltic likewise offer summer resorts well suited to many invalids, and some of them have the advantage of fine forests in the neighbourhood. Their character is somewhat less stimulating compared with the resorts situated on the North Sea, and the following may be enumerated: Marienlyst, near Helsingör; Düsternbrook, near Kiel; Travemünde, Doberan, Warnemünde, Putbus, Heringsdorf, Misdroy, Swinemünde, Rügenwalde, Colberg, Zoppot, and Cranz. On the coasts of Norway, Sweden, and Denmark there are many places suitable for summer resorts and possessing a very bracing, stimulating sea air.

On the southern hemisphere there are, no doubt, many places which might be mentioned in this connection, but they are as yet only of limited value, with the exception of Tasmania or Van Diemen's Land, as it was formerly called (lats. 40° to 43° S., longs. 144° to 148° E.), situated S.E. of Australia, and being of particular value to that continent.

Tasmania.

The form of this island is heart-shaped, with its base directed to the north, the town of Launceston being situated there, and the flattened apex, with Hobart Town, the capital, having a southern aspect. The surface of the island is highly diversified; two mountains rise to over 5,000 feet above the level of the sea, and there are a good many elevations ranging from 4,000 to 4,500, Mount Wellington, which rises close behind Hobart Town, and the summit of which is frequently covered by snow, being 4,166 feet high.

The climate of Tasmania is cooler, moister, and more equable than that of Australia, and is described by Dr. Brown ('Australia for Consumptive Invalids,' 1865) and others as most agreeable and healthy. Hobart Town is as yet the most healthy place, and possesses beautiful surroundings. The mean annual temperature is, according to Brown, 53° F., that of the winter being 44°, and of summer 62·8°; the amount of rain varies and measures about 23·5 inches; the number of rainy days, according to Martin in his work on the 'English Colonies,' is 100 in dry years and 120 in wet ones. The westerly winds, blowing from the sea, prevail during by far the

greater part of the year, whilst the dry and hot winds, coming from Australia, and raising the temperature to 95° F. and higher, blow but for a few days. The winter months (June to August) are frequently very cold in the interior of the island, and at the more elevated places; spring (September to November) is described as invigorating; summer (December to January) is considered to be very agreeable, and autumn is known as the best time of the year.

More rain falls at Launceston than at Hobart Town, and the range of temperature is also greater at the former place.

Tasmania, and more especially Hobart Town, are much frequented by Australians during the summer, in order to escape the great heat. The sanitary conditions are fairly good, and the mortality is 20 to 23 per 1,000. It is not likely to be much used by Europeans in the immediate future, except for a temporary stay during sea voyages.

III. Marine Climates with Low Degree of Humidity.

We have to consider principally the *warmer* localities, for the colder dry climates of the sea coast are as yet not, or at least quite exceptionally, used as therapeutic agents. The Mediterranean group commands our attention before all others, as being better known and more visited. The general characteristics of the Mediterranean have been pointed out in discussing the warm and moderately moist marine climates. We can, therefore, take at once into review the different regions of importance, and will commence with the Riviera di Ponente, or Western Riviera, including the places situated between Hyères and Savona. Here we find a narrow strip of coast open to the south and south-east, partly also to the south-west—that is, towards the Mediterranean—having a dry soil, composed mostly of chalk; and behind it are several ranges of mountains rising from lower to higher elevations, which aid in several ways in raising the temperature of the coast—firstly, by screening it more or less from the cold north wind; and, in the second place,

Riviera di Ponente.

they absorb heat during the hot part of the day (and year), and allow it to radiate during the cold part of the day (and year). At some places also direct reflection of heat occurs. It is to these conditions, and also to the warming influence of the sea, and the diathermanous state of the air for the sun's rays, that these regions owe their high winter temperature, which is on an average from 48° to 53° F., or even higher during the 6 months of the season. The air is dry, though by no means excessively so, the mean relative humidity being about 65 to 70 per cent. during the 6 months of the season. The sky is clear; there are many sunny days, and the thermometer, exposed to the direct rays of the sun, rises in the winter to 112°, and even 122° F. The fine days are numerous, from 110 to 120; those on which the sky is wholly overcast are few, from 10 to 20; the number of rainy days ranges from 45 to 50 during the 6 months of the winter season. Invalids may, therefore, on most days, with proper precautions, spend an hour, or even several hours, in the open air. As is usual on the sea coast, land and sea breezes alternate daily, and consequently there is a free interchange of air. Though the amount of wind encountered will, of course, vary much at different places, we may say that on the average for about 60 days the air is almost calm, on 80 days there is a moderate or a fresh breeze, and during the remaining 40 a strong wind blows, which at times rises to a gale. December and January are, on the whole, calm months, whilst from the middle of February to the beginning of April the cold and dry mistral is not at all unfrequent. The climate is cheering to the mind and invigorating to the body. As disadvantages may be mentioned the great difference between the temperature in the sun and in the shade, also between rooms having a northern or southern aspect, the considerable change of temperature at sunset, the occasional occurrence of high winds, and the very trying dust, the composition of which is, however, almost exclusively mineral and not of an organic nature. The mosquitoes are likewise mentioned among the drawbacks, but they are in fact merely an annoyance to which we may get accustomed, and against which we may guard to a certain extent; they do not harm invalids seriously.

The accommodation in hotels and private dwellings is on the whole very good, though expensive for people with limited means; there is no lack of amusements, and at some places they are almost too plentiful. In fact, by these amusements, and the thoughtless way in which churches are entered, the good effects of treatment may frequently be counteracted, and even fatal disease is sown. Hence physicians should be very careful in the directions they give to patients, and in their supervision. But it frequently happens on the Riviera that the necessity for medical advice is not sufficiently considered, and the physician is either not consulted at all or only on special occasions. In such cases strict medical supervision, so necessary for consumptive patients, is quite out of the question. Patients with phthisis, or a tendency to it, frequently have healthy people living with them, who visit the sunny south merely for pleasure; they join the latter in long walks and drives, get heated in the sun, and, although thinly clad, expose themselves to the change of temperature at sunset, or between sun and shade; or they frequent parties, clubs, and gambling rooms, to return from them heated and at a late hour of the night. It is only when attacks of pleurisy, pneumonia, or hæmoptysis occur, or when a bronchial catarrh, which was scarcely noticed at the beginning, has become much aggravated, that the doctor is called in. Many so called 'colds' are simply caused by avoidable indiscretions, and are then ascribed to the 'bad climate' or the 'exceptionally bad season.' It must be admitted that even on the Riviera there are sometimes very bad months, with only about 10 bright, 5 cloudy, and 15 rainy days, and a mean temperature of only 37·5° to 41° F. Such exceptional weather may even last throughout the whole of winter and spring, as it did during the season 1878–79. Still, according to the evidence of Dr. Frank and Dr. Marcet in Cannes, the results of treatment were satisfactory at that time. I may add that my own patients, at least those with phthisis, did better on the whole than in most other winters; simply, I suppose, because the bad weather compelled them to take care of themselves. I have no doubt that, if the existing advantages were properly used, under medical direction, much better results might be gained in future than has been the case hitherto.

The season commences at the end of October (though some patients may be sent as early as the middle of the month) and lasts until the end of April; in some cases invalids should remain longer. Nearly all ought after this date to make a stay at some other health resort suitable for that time of the year, as it is not advisable for them to encounter their own changeable climate before the beginning of June. Those with whom the mistral does not agree, and who are able to travel, should resort in February to some place where they escape its influence.

The classes of invalids who are likely to be benefited by a residence on the Riviera during winter and spring are as follows: those to whom sun, warmth, light, moderate dryness of air, good food, and other comforts are a necessity, who in the dull, damp and cold, changeable climate of their homes are either not able or unwilling to take outdoor exercise, and, owing to failure in appetite or strength, are liable to fresh attacks of illness, or to exacerbations of existing disease; the weak and debilitated, the prematurely old, the scrofulous, either infants or adults; cases of anæmia, glycosuria, rheumatism, and gout; cases of chronic catarrh, not only of the larynx and bronchi, but also of the stomach and intestines; patients who have only partially recovered from pleurisy or pneumonia; the subjects of many forms of phthisis if they are not specially erethic or liable to feverish attacks, or patients with changes which might lead to phthisis. For patients of this large class, who suffer from the more active forms of disease, the well-protected places alone are suitable, whereas the indolent and stationary varieties of phthisis permit of great choice. The Western Riviera cannot be recommended for most cases of hysteria, for cases of purely nervous neuralgia, in nervous asthma, great irritability of the nervous system in general, dry catarrh of the larynx and bronchi with nervous (hysterical) complication, and in so called florid phthisis.

After these general hints regarding the whole of the Western Riviera, a short description of the different resorts will follow in the order of their position from west to east.

Hyères is most beautifully situated about three miles from the sea, with southern vegetation and particularly fine palms; it is very sunny and bright, but the mountain barrier protecting

it to the north is not complete, and gives easy access to the north-westerly wind (mistral). During the spring it is therefore much less suitable for many invalids than the more easterly places. On the other hand, the distance from the sea is an advantage to many nervous constitutions. I know of many cases in which a residence at San Remo, Mentone, Bordighera, or Cannes did not agree, on account of their proximity to the sea, whilst at Hyères the same patients got rid of their nervous cough, asthma, or neuralgia. Hyères is well provided with hotels and lodging-houses, and belongs to the less expensive places of this much-frequented region.

Hyères.

Costebelle, about two miles distant from Hyères, lies nearer to the sea, is better protected by hills and trees, and is less dry. It is indicated, therefore, in appropriate cases, but offers less accommodation, and, as a rule, there is no physician resident there.[1]

Costebelle.

Cannes, situated on the beautiful Bay of Napoul, is one of the finest spots in Europe. It is open to the south, but the small island group of 'les Lérins' moderates the southerly winds, which at times blow with great force. To the west the bay is protected by the wooded and very picturesque Esterels, to the east by the 'Cap de la Croisette,' to the north by the advanced hills of the Alpes Maritimes with their high mountain chain behind, the latter, however, being too far removed to afford complete protection. According to De Valcourt, Marcet, and others, the meteorological conditions do not differ much from those already described among the general characteristics of the Western Riviera. High winds are not at all rare, particularly the mistral in February and March; there is no lack of dust, and the climate can scarcely be called perfect. Dr. Frank, however, from many years' experience, has shown that with proper precautions, and taking advantage of the protecting hills and clumps of firs, cases of phthisis, if not acute or in too erethic subjects, may frequently be arrested or cured; that sufferers from atonic arthritis and rheumatism, scrofulous individuals, and decrepit persons in general may be

Cannes.

[1] St. Raphael, near Fréjus, deserves mention here, having been recently started as a winter health resort. It lies under the Esterels, well sheltered from northerly winds, and the country immediately behind it is very fine.—*Tr.*

much benefited by the climate; but great care is necessary at a place so enticing in scenery and social attractions. It does not, as a rule, suit those subject to neuralgia, hysteria, or feverishness. Cannes lies on two bays, an eastern and a western, and between these is a promontory with a hill on which the old town is built. The western bay possesses the finer scenery, but the eastern is somewhat better protected against the mistral, and the houses extend farther inland, a matter of great importance to a number of invalids who do not get on well when living close to the sea. Both bays have very good hotels and villas; several new hotels of great excellence have lately been built in the East Bay. Invalids who do better at a greater elevation above the sea, and who at the same time do not mind living some distance from the town, find suitable quarters at the Hôtel Californie, with a beautiful view of the sea.

Further removed from the sea, and in a well-sheltered position at the end of the East Bay, the village of Le Cannet is situated. As yet it has not found much favour with foreign visitors, but it promises to be at a future time, for patients requiring shelter, the best and most noted place of this part of the Riviera.

Le Cannet.

Antibes, the ancient Antipolis, is not yet much frequented for the winter months, but it affords moderate shelter and may be more utilised in the future.

Antibes.

Nice, well known by the descriptions of Sigmund, Lippert, C. T. Williams, and many others, for its beautiful situation, was formerly a chief resort for consumptive and other invalids from the north, but has lost its high repute during the last thirty years on account of the alleged treachery of its climate, and is now mostly visited by people in pursuit of change and pleasure. It must be admitted that the changes of temperature are very great, even in sunny places, when passing from a sheltered position to a spot exposed to winds, and likewise on passing from the sun into the shade. A great part of the town is also exposed to the north-east wind, owing to a gap left in the surrounding heights by the Paillon torrent, and the mistral is often very annoying, the protection by some rather low hills to the north-west being insufficient. But the character

Nice.

of the climate is remarkably sunny and invigorating, and the bright days considerably exceed in number the dull and rainy ones. If, therefore, the situation for residence be well selected, and the existing advantages used with discretion, particularly with regard to amusements, a great deal of good may be gained even in phthisis, especially in its less active forms and in patients of torpid constitution; while cases of rheumatism, gout, and senile debility are much benefited by the dryness of the air and the abundance of sunshine. Invalids suffering from phthisis, or otherwise requiring much shelter, ought not to live near the Promenade des Anglais, but in the Quartier Carabacel or in Cimiez, both of these places being at some distance from the sea (the former from half a mile to a mile, the latter three miles). They are less dry, not so dusty, and better protected from winds. Concerning the meteorology of Nice, details may be found in the works of De Valcourt, Lippert, and others; we will not enter into them, as in the essential points they do not differ from those already mentioned in our general remarks. An unbiassed and intelligent gentleman who was cured of incipient phthisis by spending five winters in Nice, and who always resided either in Carabacel or Cimiez, has recorded the state of the weather during 720 days. Of these 450 were fine, 124 rainy (many being fine at intervals), and 146 more or less overcast.

Villafranca. Villafranca (Villefranche), situated on the bay of the same name, is well protected and decidedly warmer than Nice. According to Carrière and Walshe, it would be a very good place for those in want of shelter and sun, if there were sufficient accommodation. This, however, is as yet entirely wanting.

Beaulieu. A little more to the east, between Nice and Monaco, and in a sheltered position, lies Beaulieu, where arrangements are being made for the reception of winter visitors. Under the immediate protection of steep rocks to the north, north-east, and north-west, the vegetation is most luxuriant; oranges, lemons, figs, and caroubas are plentiful, and hardly anywhere do we meet with finer old olive trees, some measuring from 20 to 23 feet in circumference. Hence it is probable that the place will prosper as a health resort.

Monte Carlo. Monte Carlo has not only a sheltered position, but abounds in beautiful scenery. Were it not for the well-known gambling tables, many classes of invalids might be sent there.

Roccabruna. Farther eastward, towards Mentone, we pass the ancient village of Roccabruna. It is beautifully situated, and its houses are built along a rocky declivity which protects them from cold winds and raises the temperature of the whole neighbourhood by reflecting the sun's heat. During several visits on sunny days of November, I found the temperature rather high, almost 1 F. higher even than in the eastern bay of Mentone. Hitherto, however, nothing has been done for the reception of visitors.

Mentone. Mentone has a south-easterly aspect and is protected from cold winds by three consecutive ranges of mountains; a rocky promontory on which the old town is built divides the bay at Mentone into an eastern and western portion; the East Bay, at the base of a steep rocky declivity, skirted by a narrow strip of land lying close to the sea, may be termed the most sheltered portion of the Riviera, while in the West Bay the hills do not descend so rapidly and do not come so near the sea. Consequently the protection in the latter is not so complete, particularly as there is a gap in the sheltering mountain wall caused by a torrent. On the other hand, this western part has the advantage that a number of houses are built at a distance from the shore, and thus are suitable for invalids who would be deprived of sleep by the noise of the sea, if residing on the East Bay. Mentone, particularly the western part of it, has sheltered walks near and far, and charms visitors unceasingly by the picturesque configuration of its surroundings as well as by its rich vegetation.

Mentone, with a mean annual temperature of 61° F. (De Bréa), exceeding that of Nice by 1·8° and of Cannes by 1°, has the advantage of a more equable temperature and better shelter, particularly in its eastern part. It is considered to be less dry than the neighbouring places; at least the rainy days for the year are reported to be 80, while for Cannes the mean of 70 is given, for Nice between 60 and 70, and for San Remo only 48. Although one of the more recent

health resorts, it has become better known than almost any other place in this region, owing to the descriptions given of it in scientific works. The principal publications have appeared in English by Henry Bennet (the founder of the English colony, to whom the whole neighbourhood is much indebted) and Liardet, in French by Bottini and Farina, in German by Stiege and Dührssen.[1]

For cases of phthisis in the first and second stage, without pronounced feverish symptoms, where shelter from cold winds, sunshine, light, warmth, and home comforts are required, the eastern bay is equal, or perhaps superior, to any of the principal health resorts in Europe; but a good many healthy persons and invalids dislike the place on account of its deficient circulation of air and close proximity to the sea, with its noise and other exciting influences. Among sufferers from neuralgia, asthma, and dyspepsia I have even met with instances of complete intolerance to this local climate. The West Bay does not share these drawbacks to any extent, but it does not afford as much shelter.

Bordighera.

Bordighera, the first health resort we come to beyond the Italian frontier, is more exposed than the eastern part of Mentone, but it has plenty of sunshine, and cold winds have no direct access. It therefore gives fair promise for the future. At present the best hotels and private dwellings are too near a very dusty and frequently windy high-road. After the completion of the houses just commenced among the olive groves some distance from the sea, and when new roads have been made, many invalids might be sent there with advantage. This has been advocated for some time by Dr. Richard Schmitz, of Neuenahr, who has passed several winters at Bordighera. Its luxuriant plantations of palm trees seem to confirm this view, but we must not overlook the existence of valleys to the west of Bordighera proper, which are very tempting for excursions, but give ready access to cold winds,

[1] In the work of Dr. Sparks, which has appeared just too late for us to make use of, we find an unbiassed account both of Mentone and the whole Riviera. It is founded on local knowledge, and written with great judgment, and may be strongly recommended as a handbook for those who require information in regard to the Riviera (*The Riviera*, by Edward Sparks. London, Churchill, 1879).

lowering the temperature of Bordighera and making it a 'breezy' resort.

Ospedaletti.

On the road from Bordighera to San Remo lies the small bay of Ospedaletti, well protected to the east and west by wooded mountain spurs, and fairly also to the north by a hill. The lemon trees denote sunshine and shelter, but the space is so much confined that Ospedaletti can never extend to any size.

San Remo.

San Remo is situated on a semicircular bay facing due south. The old town is spread out pyramid-like, whilst the visitors' quarters lie to the east and west in the midst of olive groves. It is completely protected to the west and east by promontories projecting far into the sea, to the north by a treble mountain barrier rising from 500 and 650 feet up to 8,000. During the last 12 or 15 years San Remo has risen to the foremost rank as a winter health resort, owing to the great advantages of its position, and also undoubtedly to the recommendations of English and German physicians (Whitley, Daubeny, Freeman, Hill Hassall, Biermann, Broeking). Meteorological observations show its climate to be warmer and more equable than that of Nice, Cannes, and Hyères; it comes nearest to that of Mentone, but has a slightly higher temperature. Broeking ('Vierteljahrsschrift für Klimatologie,' 1876, p. 40), from records at the San Remo observatory, gives for the whole year a mean temperature of 61·8° F.; for the five coldest months (November to March), 52·1°; for January, the coldest month, 49·0°; mean range between the maxima and minima for the period from October to April, 4·1°; mean of extremes for the same period, 14·71°. Mean of barômetrical pressure, 29·98 inches; mean range of extremes, 0·747 inch. From the month of January (with a difference of 0·992 inch) it decreases until July (with 0·488 inch), after which month it rises until December and January. The fluctuations between 9 A.M. and 3 P.M. are on an average 0·016 inch, but they are at times much greater—that is, between 0·196 and 0·472 inch. The mean vapour pressure for the winter is 0·267 inch; minimum in January, 0·232, after which it increases coincidently with the rise in temperature until July, with a maximum of 0·623, and decreases again from July until January. As

regards the daily range, a rise generally takes place between 9 A.M. and 3 P.M., and there is a corresponding fall during the rest of the day. Mean of relative humidity, 66·7 per cent., being lowest at noon with 64·5 per cent., highest in the evening with 68·8; range during the different months of the year not considerable; mean of the winter months equal to that for the year—that is, 66·7 per cent. March is the dryest month with 64·3 per cent., September the moistest with 68·2. The daily range is sometimes very considerable, up to 40 and 50 or even 60 per cent. Cases of diarrhœa and hæmorrhage have been known to arise at times when the humidity of the air was quickly increasing. The state of the sky for the five coldest months (November to March) is recorded as follows: 52 very bright days, 69 partly bright, 33·5 overcast, 26 rainy, and 1 day with a hurricane. Mean proportion of ozone for the whole year, 6·2; it is generally higher in daytime than at night. Evaporation during the five winter months averages from 0·12 to 0·16 inch. The prevailing winds for the same period are N.E. and E. (157 times), N.W. and N. (154 times), whilst S.W. and W. are less frequent (101 times), and S.E. and S. are very rare (25 times). N.E. and E. were noted chiefly in March, N.W. and W. in November and December, S.E. comparatively often in March. S.W. and W. increase in frequency from January to March. Calms are rare.

The reports of the San Remo hospital show (Broeking) that catarrhs and bronchitis are frequent; inflammatory states of the lung tissue proper are, however, rare, and 'caseation with termination in phthisis occurs only in isolated cases.' Scrofulosis, owing to narrow streets and close, sunless houses, is frequent in children, but adults are not often subject to it.

From the preceding remarks the conclusion seems obvious that, for the treatment of the conditions specified in our general remarks, San Remo is as good as any other resort on the Riviera; but certain consumptive patients who require a great deal of shelter will generally get on better at the eastern bay of Mentone.

Alassio. Alassio, on the road from San Remo to Savona, has quite recently become a winter resort, its merits from a meteorological point of view having been praised by Dr.

Schneer. The mean annual temperature is 61·95° F., the monthly means being for January 48·52°, February 50°, March 56·21°, April 57·29°, May 62·51°, October 62·53°, November 53·35°, and December 51·44°. The mean of the five coldest months is 51·89°, and the mean of the daily fluctuations for the five coldest months 4·32°. During the same period, according to Dr. Schneer, invalids may sit in the open air on 77 days; they may take exercise, but should not sit down on 65 days, and are obliged to stay indoors on 8 days. So far as conclusions can be drawn from a passing visit, the author does not consider the shore, where the hotels and the town are situated, sufficiently protected from the north and north-east winds, though good shelter may be found nearer to the range of hills.

Results of the author's own observations.

Though the results coming under the notice of a single observer are of but slight value, we shall give a short summary of the cases we have sent to the Western Riviera, as they may probably be of some utility taken in conjunction with the experience of others. To begin with the consumptive patients: of these 63 spent one winter or several winters there, making a total of 124 winter residences. Of these consumptives 36 were in the first stage, and 22 of them showed improvement, 3 remained doubtful, and 11 became worse; of 15 in the second stage 6 improved, 3 remained stationary, and 6 became worse; of 12 in the third stage 2 improved, 5 remained stationary, 5 became worse. To sum up, 30 (47·6 per cent.) were improved, 11 (17·5 per cent.) remained stationary, and 22 (34·9 per cent.) became worse.

Drs. C. J. B. and C. T. Williams[1] have published notes of 152 consumptive patients sent for the winter to the shores of the Mediterranean, giving a total experience of 229 winter residences. Of these patients 62·5 per cent. were improved, 20·39 per cent. remained the same as when they set out, and only 17·11 per cent. became worse. The results recorded by these observers are somewhat better than our own, but we have no doubt that even more favourable results might be gained if patients took greater care by placing themselves under the continuous guidance of physicians, and resisting the

[1] Dr. C. T. Williams, *The Influence of Climate in the Prevention and Treatment of Pulmonary Consumption.*

many temptations afforded by the climate and by social intercourse. Nowhere else have we met with the occurrence of so many acute and subacute affections as among our patients in this region. Our notes respecting this point extend over only 41 patients who have spent on the Riviera 94 winters, or altogether 2,254 weeks, during nearly 420 of which they had to remain either in bed or indoors—of course irrespective of indoor days occasioned by bad weather. The chief causes were bronchitis, pneumonia, pleuritis, laryngitis, angina tonsillaris, febris rheumatica, and hæmoptysis—all affections which in many, perhaps in most, cases might have been avoided. Of 20 cases of *emphysema* with chronic catarrh our notes show decided improvement in 15, in 3 no appreciable change took place, and 2 became worse by intercurrent inflammatory attacks. We never include cases which were sent away soon after arrival, because the climate did not suit them. Of 28 cases with a *liability to bronchial attacks and chronic catarrh* without emphysema 20 improved, 3 did not give a decided result, 5 cases became worse in consequence of acute attacks. Of 35 patients subject to *chronic rheumatism* 24 improved considerably, 11 did not derive much benefit. The latter number would be smaller if the damp and cold winter of 1878–79, which did not prejudice cases of phthisis, had not affected rheumatic patients most unfavourably, 6 cases out of the 11 unfavourable ones being from that winter. Of 29 cases of *gout* improvement lasting for some time took place in 15, temporary amelioration in 7, while in 6 no appreciable difference was noticed, and 1 death took place from zymotic disease. Of 14 patients with *chronic albuminuria* 8 got on comparatively well, in 5 no decided improvement took place, and 1 died in a uræmic attack after exposure to cold and wet. In a great number of *scrofulous* and *badly developed children* the result has been very satisfactory. The greater number of cases with catarrh of the fauces, the stomach, and the intestines showed improvement. Under the heading of *slow recovery* after acute and zymotic disease, inclusive of syphilis, we have notes of 32 cases, 28 of which made very good progress, while 4 contracted acute and subacute affections—that is, rheumatic fever 2, pleuritis leading to phthisis 1, pneumonia, likewise

ending in phthisis, 1—in each case owing to some clearly proven imprudence. In the large group of states of *constitutional weakness* with deficient circulation and accompanying apepsia the results were mostly favourable, but many cases complicated with hysteria, neuralgia, or with a tendency to mental disease had to leave the Riviera for other and less exciting climates, such as Pisa, Rome, Pau, Venice, Arcachon, the Italian or Swiss lakes, the English south coast, Meran, Botzen, or subalpine stations. In the still larger group characterised by waning power and failing of functions from *senility*—the natural as well as the premature—with a tendency to catarrhs of the mucous membranes, to dyspepsia and flatulency on the slightest dietetic indiscretions, to glycosuria, rheumatism, anorexia, &c., the result was generally satisfactory in so far as the sunny and warmer atmosphere, aided by distraction and abstention from exhaustive mental work, produced a state of well-being or relief in all the symptoms during the time of residence or for a longer period. For this class of invalids Cannes and Nice seem to be, in our opinion, particularly adapted.

The more easterly places of the Riviera di Ponente do not as yet make a claim to the appellation of 'climatic health resorts,' while the Riviera di Levante, or Eastern Riviera, on account of the greater humidity, has been treated among the moderately moist places.

Naples.

Farther to the south, on the western coast of Italy, Naples and its nearest neighbourhood require mention. Although very beautiful, and with a climate seemingly equable, they are hardly suited to invalids for a long sojourn, but may be chosen as resorts for distraction and recreation. Dr. O. Diruf, sen., of Kissingen, has published in the 'Deutsche Klinik' of 1861, interesting letters from Naples, to which we refer, and recently an instructive article by Dr. Macpherson has appeared in the 'Edinburgh Medical Journal' (1875) on the health resorts of the Bay of Naples in ancient and modern times.

Castellamare.

Castellamare and Sorrento, with very attractive scenery, lie on the northern side of the peninsula of Sorrento, are exposed to the winds from N.W., N., and N.E., and are only adapted for invalids during the second half of spring, in summer, and autumn. Castellamare, with delightful and

shady walks, is the ancient Stabiæ, recommended by Galen as a mountain health resort for consumptives. Very likely the excellent milk and pure air found here by invalids coming from the ancient Roman towns were the chief causes that effected the cure.

Cassiodorus speaks of a 'Mons Lactis' as a resort for phthisical patients, situated near Stabiæ. It seems that the present Lettere, distant about six miles from Castellamare, and situated on the northern spur of Monte Sant' Angelo, corresponds with it; a bracing place, with shady and picturesque walks, but without a proper hotel. In some of its villas, however, as well as in houses situated on high ground above Castellamare, among which the Hôtel Quisisana deserves commendation, many invalids coming from other places in Italy might spend the latter part of spring, the summer months, and autumn up to the end of October, although for most northern constitutions the heat in summer is too oppressive. Italians frequent Castellamare not only in quest of the air, but also for sea bathing and the drinking of mineral waters.

Lettere.

Other places of similar merits are Vico Equense, Meta, and Massa Lubrense.

Salerno, the celebrated Salernum of ancient times, situated at the northern angle of the magnificent Gulf of Salerno, has lost its fame as a health resort. It offers good shelter and a sunny, moderately dry, invigorating climate, but a good many malarious affections, which are partly generated by the emanations from the neighbouring marshy grounds of Pæstum, occur in this region during the summer and autumn months; even in winter these fevers do not quite disappear, although they are much rarer.

Salerno.

Amalfi, at the northern margin of the Gulf of Salerno, faces the south, has a warm and invigorating climate and a great number of bright days, but the protection from the north is interrupted by a gorge. A somewhat similar description will apply to the picturesque places situated on the shore between Salerno and Amalfi (Maiori, Minori, Atrani).

Amalfi.

The beautiful island of Capri, in its northern half, is exposed to all winds excepting those from the south, and these parts should not therefore be used except during the hot season;

but the southern portion is much better protected, as is amply shown by its vegetation. The air is dry and, according to the testimony of a friend who has lived there for two years, there is not much rain; there are many bright days; the soil (limestone) is dry; but the winds coming from the south are said to be at times relaxing. The Hôtel Quisisana in the village of Capri has a good situation.

Capri.

The island of Ischia is in most parts too much exposed for winter residence; but from April to October it suits many categories of invalids very well, and its hot baths are particularly serviceable in cases of rheumatism and gout. The best place for this purpose is Casamicciola, at the northern base of Monte Epomeo, which has several excellent hotels, and the advantage that good medical advice is easily procurable, either from the island itself or the neighbouring Naples.

Ischia.

Catania, situated on the eastern shore of Sicily, has, according to the Meteor. Ital., a mean temperature of 65·3° F., winter 52·7°, spring 60·8°; rainfall 18 inches, distributed chiefly over winter and autumn; 53 rainy days. Its position to the S.S.E., and at the foot of Mount Etna, the summit of which is covered with snow in winter, exposes it to cold winds coming across this mountain (N. and N.E.) However several of our patients (arrested phthisis) got on very well there, but complained much of ennui, as there was very little to interest them.

Catania.

Syracuse, the meteorology of which, as regards warmth and rainfall, is similar to that of Catania, is in many places too much exposed to winds, and is not therefore fit for cases of phthisis; with the exception of a few sheltered parts it has as yet not been in general use as a winter health resort. The neighbourhood in the direction of the interior of the island is not quite free from malaria.

Syracuse.

The island of Malta, or rather its capital, Valetta (lat. 35° 54′ N., long. 14° E.), has a mean annual temperature of 65·95° F.; winter 55·99°, spring 61·18°, summer 76·17°, and autumn 70·44°; fluctuations of temperature slight; amount of annual rainfall 23·93 inches, with chief quantity (72 per cent.) in winter; clear air with much sun.

Malta.

Although splendidly situated, it is rarely used as a health resort; not even by visitors from England, to which it belongs. For the majority of consumptive patients it is certainly too windy; complaints are especially made about the relaxing effect of the Sirocco, the scarcity of level walks, and want of shade; but we have seen good results in rheumatic subjects and those who require warmth and sunshine. So cautious an authority as Walshe speaks well of the influence of the climate in apyretic phthisis, even in the third stage.

Of the islands in the Mediterranean, the Balearic Islands may be mentioned as 'health resorts of the future.' The largest of them, Malorca, or Majorca, has several well-situated places, among which the town of Palma (lat. 39° N., long. 2° E.), built on a bay facing south, affords the best accommodation. Mean annual temperature (according to Hann) 63·5° F.; winter 52·5°, spring 60·1°, summer 75·2°, autumn 65·1°; amount of rainfall 27·16 inches. Our experience is confined to information derived from a few consumptive patients with stationary disease, and without pyrexia, who had paid passing visits to the islands. They spoke well of them, but pointed out that for invalids with more aggravated disease no adequate provision was made.[1]

The Balearic Islands; Palma; Mahon.

Barcelona (lat. 41° N., long. 2° E.), at the north-east coast of Spain, is in many respects well situated, particularly owing to its being easily accessible from the South of France, and so near to the summer health resorts of the Eastern Pyrenees. To the south and south-west it is open to the influence of the sea, but is sheltered to some extent from cold northerly winds by a range of moderately high hills, and possesses a variety of level and gently rising walks. Mean temperature (according to Dove) 62·4°; winter 49·64°, spring 59°, summer 76·1°, autumn 64·04° F. Mean amount of rainfall 22·44 inches, with chief proportion in autumn and spring, distributed over about 69 rainy days.

Barcelona.

[1] Dr. H. Bennet, in an article on the Balearic Islands in the *Brit. Med. Journ.* (Oct 2, 1880), expresses an unfavourable opinion regarding the suitability of these islands as a health resort. He says that, although the climate is mild and moist in winter, still the winds are too constant and too vehement, and the storms and rains, when they occur, are too violent in the winter seasons. He adds that the accommodation for invalids is very limited.—*Tr.*

Valencia (lat. 38° 28′ N.), described by Cardinal de Retz as one of the finest and healthiest places, is quite unsuitable during the months of spring and summer, on account of the dampness and malarious emanations in the air attending the cultivation of rice, but may be recommended for the latter part of autumn and the winter months (Francis). The mean annual temperature, according to Lorenz and Rothe, slightly exceeds 62·6° F., being for the winter 52·5°, and for spring 57·44°; relative humidity 66°, with only slight variations in the different times of the year. Amount of rain during the twelve months about 18·7 inches; number of rainy days 47, distributed chiefly over autumn and winter.

Valencia.

Another place on the Spanish Mediterranean coast is Alicante (lat. 38° N.), which, like the whole province of Murcia, is known to be drier than Valencia. It is tolerably well protected from north and north-westerly winds. According to Francis, it has a mean temperature of 64·4°, that of winter being 53·5° F. Amount of rain 16·9 inches, of which 38 per cent. falls in the autumn, 30 per cent. in spring, and 20·7 per cent. in winter (Lorenz and Rothe).

Alicante.

Our personal experience of the two places last mentioned, both of which afford good accommodation, is limited to a few cases of arrested phthisis without pyrexia, doing well during a sojourn of several months, and some instances of business people who resided there for ten to eighteen months engaged in commercial pursuits. The latter complained of the summer months, in the course of which disorders of digestion, occasional diarrhœa, and loss of appetite made their appearance, without, however, affecting the respiratory organs.

Malaga (lat. 36° 45′ N., long. 4° 33′ W.) is praised by Francis as the mildest place in Europe, and by Cazenave as the most favourable locality in Spain. It is built on sandy soil, formerly covered by the sea, and is protected to the north and north-west by a semicircle of hills with an altitude of about 3,300 feet. The accommodation is good in the hotels on the Almeda. The mean winter temperature is about 55·4° F., that of spring being 64·4°; the mean daily range, according to Francis, does not quite reach 4·5°, and the variations in the temperature of succeeding days and months

Malaga.

are likewise small. The same author maintains that the mean relative humidity is somewhat between that of Madeira and Nice, but the number of rainy days is only 40, that is, less than for Nice, and all our patients have described the air as dry.

On the coast of Egypt there are several places that may be named as belonging to the present division, notably Alexandria and Port Said. With similar annual means (68° to 70° F.) they have more equable temperatures than Cairo, and are less dry; but as they cannot be included amongst health resorts in the proper sense, we merely mention them, because, in case of need, they may be used by people who could engage in business there. Any such patients with arrested phthisis may stop there during the cool months, while those with rheumatism and albuminuria may remain longer, perhaps for the whole year.

Alexandria. Port Said.

On the extensive shores of Asia Minor, Greece, and the adjacent islands there is scarcely a place that could be recommended for its climate. Smyrna (lat. 37° 58′ N., long. 27° E.) has a mean temperature of 62·6° F.; winter 47·66°, spring 60·1°, autumn 64·4°; maximum of summer 109·4°, minimum of winter 15·6°. Amount of rain 24·45 inches, rainy days 67; relative humidity 64 per cent. Invalids requiring care should not be sent to this place, the changes being very great in winter, and the sanitary state of the town unsatisfactory.

Smyrna.

Larnaka, on the island of Cyprus (lat. 34° 57′ N., long. 33° E.) has a mean temperature of 68° F.; winter 51·8°, spring 64°; amount of rain 12·75 inches, rainy days 54. It is by no means free from malaria, so that a long time must pass before the climate can be made use of.

Larnaka.

Athens, in Greece (lat. 37° N., long. 23° E.), has, according to Schmidt, a mean temperature of 68°, with great extremes (105·2° and 14° F.); winter 49·2°, spring 61·9°, autumn 66·8°, summer 81·1°; rainfall 15·3 inches, rainy days 75, relative humidity 62 per cent. The climate is quite unsuited to invalids with chest disease; but in gouty, neuralgic, and rheumatic affections we have repeatedly seen good results from a residence at Athens.

Athens.

Among the dry marine climates of the southern hemisphere, the coast of South Africa attracts our attention first of all, though owing to the great distance of this region invalids can only be sent there in exceptional cases. The highland of South Africa will be discussed below with the inland, and particularly the mountain climates. On the seashore there is, to begin with, Cape Town (lat. 33° 56′ S., long. 18° E.), situated on Table Bay, at the foot of Table Mountain (3,550 feet). It has a mean temperature of 64·5° F.; winter 57·2°, spring and autumn about 64·5°, summer 71·5°; rainfall about 23·7 inches, mean relative humidity 72·3 per cent. The town itself is dusty and unpleasant; invalids do better in the suburb of Sea Point, or at the neighbouring Wynberg, which lies farther inland and has good hotels. The frequent and at times violent winds, accompanied by much dust, are a disadvantage; whilst the fact that during the hot season inland places at a higher elevation may be visited is advantageous.

The south of Africa. Cape Town.

Port Elizabeth, situated on the south-east, and Port Natal, or Durban, on the east coast of South Africa, are somewhat warmer. At all the places on these coasts great variations of temperature take place when the wind changes suddenly, that coming from the interior having a very high temperature during the hot months, and that blowing from the sea being comparatively cool.

It is not very likely that, as a rule, invalids will be sent to either of these places from Europe, England perhaps excepted; unless in cases in which the sea voyage there and back is regarded as the chief agent in the treatment, or in the case of patients at the commencement of phthisis, who might seek employment, such as is likely to be found at a port. We have met with ten such cases in young clerks, with phthisis in the first and second stage. Three of them got so much better that during the last two years the disease has made no progress, and they may be regarded as cured; while two were improved or cured only after they had removed to a mountain climate and stayed there for a considerable time, the climate of the seashore not being suited to them. Five became worse, and in three of these life was probably shortened by the stay in Africa.

Australia. New South Wales. Sydney.

The climate of Australia has many varieties, partly due to its position in the southern hemisphere (lats. 10° to 39° S., longs. 113° to 154° E.), partly to the influence of the Pacific and of the vast deserts in the interior. Of works on the climate of Australia, from a therapeutical point of view, we may mention those by Montgomery Martin, Scoresby-Jackson, J. B. Brown, Bird, and Thompson, the latest account being by E. Faber, as an appendix to his articles on the influence of sea voyages ('Practitioner,' 1876–78). The northern tropical part need not be considered, as it is not suitable for invalids; and even in the other parts the variations are very great. On the east coast, New South Wales, between 30° and 37° S. latitude, is considered to have a healthy climate; Scoresby-Jackson gives the mean temperature as about 64·5° F.; winter (June to August) 55°, spring 65·5°, summer 71·5°, and autumn 65·8°. Faber's mean temperatures, deduced from a greater number of observations, are nearly 2° F. lower. During the winter months the nights in the vicinity of Sydney are frequently cold, but during the daytime the temperature is rarely below 40° F. In winter and spring not much rain falls. In summer the heat is great, and may cause a good deal of annoyance when winds prevail from the hot interior. Autumn sets in with rain and unsettled weather, but becomes genial afterwards. According to Montgomery Martin's work on the 'English Colonies,' there are about 241 fine and 48 rainy days in the year. The amount of rainfall varies, the yearly average being about 47·5 inches; the maximum of relative humidity 80 per cent. in October, and the minimum in January only 9 per cent. In winter southerly winds prevail as a rule, but in summer those from the north are more common.

It is alleged that phthisis was comparatively rare formerly, but has become more frequent nowadays. Dysenteric affections are not rare.

Besides Sydney, there are five other coast stations in New South Wales—Port Maquaire and Newcastle to the north, Wollongong, Cape St. George, and Eden, to the south of Sydney. The mean temperature of these stations varies from 63·8° F. at Newcastle to 59·9° at Eden, the latter being the

most southerly (lat. 37° S.) The maximum at Newcastle is 84°, at Eden only 77°, and at Sydney 80° F.

At some distance from the sea, that is, between it and the mountain range, there are seven other meteorological stations: Casino, Grafton, Muswell Brook, West Maitland, Windsor, Parawatta, and Liverpool. All of these have a somewhat less equable climate than the seashore stations proper, that is, higher maxima and lower minima in summer and winter, and also a greater daily range. Whereas at Sydney the daily range is only 14° F., being for January 10·7°, and for October almost 18°; it amounts to 21·6° at Maitland, and 25·2° at Windsor.

Victoria. Melbourne.

In the province of Victoria (lats. 34° to 39° S., longs. 141° to 150° E.) there are the coast stations of Yabo Island (lat. 37° S., long. 150° E.), Port Albert, Melbourne, Cape Otway, and Portland. Melbourne, the capital, lies at the mouth of the Yarra River, where it enters the bay of Port Philip (37° 5′ S. lat.) According to Faber this town has a mean temperature of about 57·7° F., the mean for the whole coast line being 1° lower. A former observer (Strzelecki) had given figures which were about 3·5° higher. Cape Otway has the lowest temperature, 55·2° F., and Portland the highest, 61°. The latter has in the hottest month a temperature of only 67°, and in the coldest of 53·6°, evidently owing to its sheltered situation on Portland Bay, and the moderating effect of an ocean current. The mean temperature of Melbourne is for the different seasons, winter 49·2° F., spring 57°, summer 65·3°, autumn 58·6°. During 17 years the temperature in the shade has been 61 times above 100° (once it reached 111°) and 52 times below 32°; the greatest yearly range was 84·5° in 1868. The mean daily range is 22·3° in summer, 18·5° in autumn, 15° in winter, and 20° in spring.

South Australia. Adelaide.

Adelaide, the capital of South Australia (lat. 34° 55′ S., long. 138° E.), lies on the River Torrens. Although it is situated at a distance of five miles from the sea, it may be considered as having a sea climate. Mean temperature 63° F.; winter 53·2°, spring 62°, summer 73°, autumn 64·2°. Mean daily range 20·7°, in winter only 15°. This would be larger if sea breezes were not by far the most prevalent. In summer the variations are greatest, owing to the influence

of the sandy deserts (25·4°), as is also the case in Cairo, according to Faber The same observer points out that the autumn months, April and May, are delightful.

In the province of West Australia the conditions of temperature are much the same, but the amount of rainfall is greater. Perth, the capital, situated on the Swan River (lat. 41° S., long. 115° E.), with attractive surroundings, has an annual temperature of 64·4°; winter 57°, spring 62·8°, summer 72·5°, autumn 66·2°. In Freemantle (lat. 32° S., long. 115° E.) the temperature of the year is lower by about 1·5°.

West Australia. Perth.

The health statistics in West Australia are very satisfactory, according to Dr. Ferguson's records. The death-rate amounts only to 12 per 1,000, whereas in New South Wales and Tasmania it is 15, and in other English colonies much higher still. One would almost think that the sparse population of the district is the chief cause of this favourable state. With a greater number of inhabitants, a similar death-rate would point to quite exceptional hygienic conditions.

As regards the question as to what extent these Australian coast climates are available for the treatment of disease, they certainly have lost much of their fame as sanatoria for consumptives. They may, however, be useful as land stations in the interval between the journey to and fro for such invalids as are sent on sea voyages, provided the season be properly selected. They are, likewise, available for colonists with a phthisical tendency. The summer months are far too hot for consumptives, but they might be avoided by removing to Hobart Town during the hot season, or by migrating to mountain stations to be established in the future. On the other hand, part of the autumn, the winter, and beginning of spring suit many invalids very well. The author has seen benefit resulting in this way in six cases of phthisis in the first stage, whilst in three cases the result was not favourable. Of eight cases in the second stage four improved, and four remained stationary or became worse. Several of the author's patients suffering from phthisis have been living for the last five to ten years near Melbourne and Sydney, and one in Adelaide, and they have all continued in good health.

B. INLAND CLIMATES.

This large group comprises a great variety of climates, and may be divided by taking as a standard either their therapeutical value or the meteorological character. However, every classification has defects, and we therefore choose the simple, though rather general, one: I. Climates of High Altitudes, and II. Lowland Climates, both of them allowing of further subdivisions.

I. Climates of High Altitudes, or Mountain Climates.

Definition of 'mountain climate.'

According to the latitude, and to the elevation above the sea and surrounding country, the difference between the various climates of this group is very great. Their feature in common is this, that the climatic elements or factors are modified by the degree of altitude, so as to give each climate a character of its own. H. C. Lombard was the first to point this out, in his instructive work 'Les Climats des Montagnes,' which appeared about thirty years ago. The subject has been further worked out by a great many authors, such as Jourdannet, Guilbert, Brehmer, &c. It is difficult to say at what height a mountain climate should be considered to commence, because the influence of the elevation above the level of the sea varies a good deal at different places. Thus in the flat and cool North of Germany, a mountain chain ranging from 1,500 to 2,500 feet in height exercises so great an influence on the climatic factors, that the vegetation has the character of a mountain vegetation, and the climate of the heights and valleys of such a mountain chain is like a mountain climate, whilst this character could not be attributed to a much greater altitude in the Himalayas or the Peruvian Andes, where cereal crops and fruit trees can be cultivated only at an elevation of more than 3,000 or 5,000 feet, and where the extreme upper limits of trees are raised to a height of 13,000 feet above the sea level. A strict line cannot therefore be drawn according to mere elevation; in higher latitudes, however, and on level lands distant from the sea, an elevation of between 1,600 and 2,000 feet will, for practical purposes, justify us in using

the term mountain climates, whilst in lower latitudes and on vast plateaux a greater elevation is necessary. Again, the upper limit to which mountain climates are, as a rule, available for the treatment of invalids varies according to the latitude and other influences (isotherms); in the northern regions of the temperate zone it will rarely exceed 3,000 feet, whilst in its middle portion, for instance the Swiss Alps, it rises under favourable conditions to above 6,500 feet; and between the tropics, as in the Peruvian Andes, it rises as high as 10,000 feet, and for the treatment of certain cases even up to 13,000 feet.

Influences modifying climatic elements; conditions of temperature.

We have already drawn attention (p. 21) to the decrease of temperature taking place with an increase in elevation above the sea. According to a table given by Lombard the increase of height experimentally found to lower the thermometer 1° F. is:—

On the Mont Ventoux (Martins)	254 feet
„ Rigi (Kaemtz)	269 „
„ Col du Géant (De Saussure)	269 „
„ St. Gotthard (Schow)	303 „
„ Faulhorn (Bravais)	306 „
„ Mountains of Spitzbergen (Martins) . . .	310 „
„ Andes (Boussingault)	315 „
„ Andes (Humboldt)	338 „
„ St. Bernard (Plantamour)	340 „

This would give an average decrease of 1° F. for every 300 feet, the value given by Messrs Schlagintweit as the rate of decrease for the Alps. However, even in the European Alps the rate of decrease is not at all uniform; thus Gaudier, according to the results arrived at by the Swiss Meteorological Commission during the years 1864–68, publishes the following table:—

Temperature decreases at the rate of 1° Fahr.

In the group of the	St. Gotthard	(15	stations)	for every	297	feet
„	„ Simplon	9	„	„	299	„
„	„ Julier	10	„	„	309	„
„	„ St. Bernard	8	„	„	328	„
„	„ Bernardino	14	„	„	332	„
„	„ Rigi	22	„	„	368	„
„	„ Chaumont	4	„	„	370	„
„	„ Uetliberg	4	„	„	411	„
				Average	339	„

We have to bear in mind that the decrease varies according to the seasons, being in summer 287 feet, and in winter 505 feet for 1° F., showing that the more elevated places are in winter comparatively warmer than in summer. There are, however, many exceptions to this rule; we will only mention that Archibald Smith gives for Lima, in Peru, 488 feet above the level of the sea, a mean annual temperature of 71·5° F., with a minimum of 60° and a maximum of 84°, whilst for the estate of Andaguaylla, situated 6,000 feet higher in the Huanuco valley, the same author gives a mean temperature varying from 66° to 71·8° F.

The bottoms of the valleys are, according to Schlagintweit, warmer in summer and colder in winter than the slopes and summits of the mountains.

The times of the day, too, make a difference; in Alpine valleys we frequently found after sunset a lower temperature at the bottom of the valley than 300 or 500 feet above it—for instance, in the Rhone valley, on ascending from Viesch to the Eggischhorn, or from Brieg to the Belalp, or in mounting from the valley of Chamounix to the Flégère—the cause being, without doubt, the descent of the colder air, cooling more rapidly on the heights, and, owing to its greater weight, accumulating in the lower regions. Hence we see that houses built on slopes, especially those with a south or south-west aspect, have in this respect more favourable situations than those erected at the bottom of a valley, whilst the latter also suffer from dampness and diminished movement of the air. Though forests screen the lower parts of the valleys from cold currents descending in the evening, they have, on the whole, the effect of making the air moister and cooler. The differences of temperature between summer and winter are, as a rule, less great in mountain climates than on inland plains. In considering the conditions of temperature prevailing in mountainous districts, the experimental observations of Beneke deserve particular mention. This author, in comparing the loss of temperature from inorganic substances (a glass flask filled with warm water), came to the result that this loss under otherwise similar conditions seems to be greater at the seashore than on mountains of moderate altitude.

Of more general application is the law of the decrease of atmospheric pressure in proportion to the height above the sea, so that at a height of 16,000 feet the pressure of the atmosphere is barely half what it is at the sea-level, and the air is correspondingly more rarefied, that is, poorer in oxygen and nitrogen. The variations in mean pressure, diurnal as well as annual, are less.

Atmospheric pressure.

The ratio that moisture bears to height cannot be defined according to strict rules. There can be no doubt that, as a necessary result of the fact that the capacity of the air for moisture decreases in the same proportion as the temperature, the *absolute* humidity is less on heights than in low-lying regions. But as regards the *relative* humidity, authors differ widely in their views. According to Gay Lussac, Saussure, Humboldt, Boussingault, and Dove it would seem to be less, but according to Kaemtz, Bravais, and Martins greater. As aeronauts in passing through successive strata of air find higher or lower degrees of moisture, so we do on mountains; and just in proportion as any place on one slope of a mountain chain is exposed chiefly to moist or dry winds, the air must be moister or drier than at the same height on the opposite slope. Plantamour found the relative humidity of the air on the St. Bernard (at 8,130 feet) much the same as that of Geneva (at 1,240 feet). Steffen found in Davos Platz (5,124 feet) the mean relative humidity for the year 1876 75·2 per cent. We must not, however, omit to mention the important fact, as pointed out by Riemer, that the average is only 57·6 at 1 o'clock P.M., whilst it amounts to 80·4 at 7 A.M. and to 87·6 at 9 P.M. Hence the humidity is low at mid-day, that is, during the time which invalids generally spend in the open air, whilst it is of an average amount in the morning and evening. For Denver (lat. 41° N., long. 104° W.) observations extending over six years give a mean relative humidity of between 40 and 50 per cent. ('Transactions of the Colorado Medical Society,' Denver, 1878).

Moisture.

As in the subject before us we have chiefly to consider the case of persons who spend a great portion of the day in their rooms, attention must be drawn to the fact that in Alpine regions the air, particularly in winter, is much drier in rooms than in the open air; thus Volland found in October 1875 in

Davos-Dörfli a mean relative humidity of 87 per cent. in the open air at a temperature of 37° F., whilst in a room at 55° it was only 57·6 per cent.

In a discussion on the moisture of the air with regard to the therapeutics of climate, the temperature of the air must always be taken into consideration at the same time as the degree of relative humidity, because the respired air is heated by its contact with the lungs, and is saturated with watery vapour, or very nearly so. Air at 32° F., containing 80 per cent. moisture, must abstract much more moisture from the body by pulmonary, and to a less degree by cutaneous perspiration, than air at 60° and with the same amount of moisture. Steffen, in his 'Communications on the Meteorology of Davos' (Bâle, 1878), has rightly pointed out this fact, and his views have always been shared by us, though we can hardly hold with him that the air expired has always the full bodily temperature of 98·4° F., and is quite saturated to that degree, but think it probable that when the temperature of the respired air is very low, that of the expired air is not higher than from 85° to 95° F.

We have pointed out under the head of The Moisture of the Air how much the amount of rain depends on the position of the mountains to the rain-bearing winds, and that it is, therefore, subject to many variations in different mountain ranges, and in different parts of the same mountain range. Thus it is greater in the southern and south-western portion of the Alps than in the northern and north-eastern, being excessive on the southern slopes of the Himalayas, where it ranges from 118 to 158 inches, whilst it is less in some valleys which are sheltered by mountain chains lying in the direction of the rain-bearing winds, such as the Upper Engadine. Gasparin, from observations taken on the course of the Rhone, the Rhine, and the Po, came to the conclusion that the amount of rainfall increases with the height above the sea, and, as regards Switzerland, he is supported by Chaix's results, based on the reports from ninety-six stations. Thus the average for fifteen stations on the plateau between Bern and Constance is 39·37 inches, whilst that for twenty-five more elevated stations between Beatenberg and Davos amounts to 57·52 inches. This does not hold good for the mountain ranges of America, either North or

South. The amount of rain, however, is no criterion of the moisture of the air, for there are regions, such as the coast of Peru near Lima, where it scarcely ever rains, whilst the air is moderately moist, and, conversely, much rain may fall at a place whilst the air is dry. Generally speaking, it may be held that the air is drier in the Alps than on lowlands, and this maxim not only refers to that portion of the moisture of the air which depends on general conditions, but also to that depending on the conditions of the ground, for if this be rocky, sloping, and porous, the soil will be less moist and there will, accordingly, be less evaporation.

Fogs.

Although fogs are not wanting in mountain valleys, they are mostly confined to the lowest parts, and do not often extend far up the slopes of the mountains; on the other hand clouds, which are identical with them, are more frequent in mountainous districts of medium elevation than over lowlands, whilst they are rarer in the higher regions than at a medium or lower level. The air is clearer on heights than over low ground.

Evaporation.

Most authors who have written on mountain climates hold that the rate of evaporation in the High Alps is in excess of that on lowlands; but according to the comparative observations made at the same time by Krieger and Volland in Strassburg and Davos-Dörfli, it is, quite on the contrary, lower at the latter place than at the former (Dr. Volland, 'Verdunstung und Insolation,' Bâle, 1879). Volland explains this by the fact that the capacity of rarefied air for taking up aqueous vapour is less.

Solar radiation.

The direct heat of the sun is considered to be very great in the High Alps, in winter as well as in summer; this has been proved for the winter by the observations of Townsend in St. Moritz and of Waters in Davos, and more particularly by those of Frankland in Davos-Dörfli. According to Frankland ('On some Winter Thermometric Observations in the Alps,' *Proc. Roy. Soc.*, 1874), on December 21, 1873, the mercurial thermometer with the blackened bulb in vacuo showed at 10 A.M. 111·2° F., and at 2.50 P.M. 113°, whilst on the same day at Greenwich, according to Glaisher, the readings of a similar thermometer were in the sunshine at 9 A.M.

48·7° F., at noon and at 3 P.M. 71·5°. The maximum temperature observed in the shade was 51·7° and the minimum 35·7°. On December 22 the black-bulb thermometer marked in Davos at 8.20 A.M., 15 minutes before sunrise, – 1° F.; at 8.45 A.M., or 10 minutes after sunrise, 71·6°; at 8.50 A.M., 78·8°; at 9 A.M., 86°; at 9.45 A.M., 100·2°; at 10.15 A.M., 102·8°; at 10.45 A.M., 103·1°; at 11.15 A.M., 106·2°; at noon, 108·3°; at 12.40 P.M. (light cloud), 99°; and at 1.45 P.M. (clear), 109·4°. At Greenwich, on the same day, the readings were—at 9 A.M., 47·3°; at noon and at 3 P.M., 55° (maximum of the day). The maximum in the shade was 50·7°, and the minimum on grass in the shade 28·8°. In Davos, on the same day, a plain mercurial thermometer with black glass bulb showed in sunshine at 9.45 A.M., 30·2°; at 10.15 A.M., 33°; at noon, 38°; at 1.45 P.M., 45°; in the shade at 10.15 A.M., 24·8°; at noon, 30·2°; and at 1.45 P.M., 28·4°. A similar thermometer placed in a box lined with padded black cloth and covered with plate glass showed at 9.45 A.M., 167°; at 10.15 A.M., 185°; at noon, 212°; at 12.35 P.M., 217°; and at 2 P.M., 221°. Barometer, 24·8 inches.

On December 23 the maximum, as shown by the thermometer with blackened bulb in clear sunshine, was at 2 P.M. only 104°, whilst in the shade the thermometer stood, at 11.30 A.M., at 15·1°, and the atmospheric pressure was 24·69 inches. At Greenwich the maximum of the sun temperature was 73° at 2 P.M., whilst at noon only 54·6° were registered. The maximum in the shade was 46·9°, and the minimum on grass in the shade 27·9°. On December 24 Frankland, on the summit of the Fluela Pass, 7,890 feet above the sea, found the temperature in the sunshine 108·1° at noon, or slightly lower than the highest temperature observed at Davos at the same hour (108·5°); temperature in the shade on the Fluela Pass at the same hour 19°. On December 25 and the days following, when with a clear sky minute snow crystals were seen floating in the air, the sun temperature at 1.45 P.M. was only 95°, whereas at noon it was 104°; the temperature in the shade standing at the same time at 15·6°. The much higher temperature at Davos, compared with that recorded at Greenwich, is of the greatest importance for the therapeutics of climate. It was formerly supposed that also in summer the sun temperature in the High

Alps exceeded that recorded on plains, but Volland's observations, comparing the results obtained under similar conditions by Krieger at Strassburg, showed that, as to the mean temperatures for July, August, and September, there was an excess in favour of Strassburg, the figures being for the latter station 146·3°, 147·4°, and 129·6° respectively, whilst at Davos 132·8°, 132·8°, and 117·3° were registered. It is only in October that Davos shows an excess, i.e. 113·9° compared with 97° at Strassburg. Volland's observations prove moreover that although in winter the sun temperature in the High Alps is considerably in excess of that observed on plains, it is in the Alps lower in winter than in summer. It is a remarkable fact that notwithstanding the intensity of solar radiation the air is not much heated, so that the air respired is comparatively cold. Frankland also draws attention to the comparative uniformity of solar radiation in the High Alps during the day. Twenty-five minutes after sunrise the solar thermometer indicated 89·2° F.; at noon it stood at 108·5°, and at thirty-five minutes before sunset it recorded 91·6°, thus showing a range of only 19 or 21 degrees. The same author also points out the low shade temperatures.

Light.

Light is more intense in the High Alps than on lowlands, as the air transmits the rays of light more completely in the former than in the latter region. Accurate photometric observations are much wanted. Somewhat in support of the opinion expressed above is the fact instanced by Ludwig in his treatise on Pontresina, that photographs can be taken in Pontresina in half the time which is necessary in Chiavenna, situated in Italy at the junction of the Splügen and Maloja routes; moreover, the dark tints of many flowers, particularly the beautiful blue of the gentians, campanulas, and of the Alpine forget-me-nots, seem to point in the same direction.

Ozone.

The amount of ozone is always high, according to the observations which Messrs. Townsend and Greathead kindly made for us in St. Moritz during the years 1869–71, and this seems to be the generally accepted view.

The air is, as a rule, much freer from admixture with organic and inorganic dust than on lowlands; this depends, however, on conditions which vary greatly at different places.

Purity of the air.

Wherever in mountain valleys towns, factories, and highroads increase largely, organic and inorganic dust with its consequences must necessarily arise. Again, where many persons are crowded together in small and badly ventilated rooms, as, for instance, the lace makers in Appenzell, purity of the air is out of the question, even should the places be situated at an elevation of 10,000 or 12,000 feet above the level of the sea. Where decaying vegetable or animal substances in large quantities are exposed to the influence of moisture and warmth, the air must lose its purity. But, on the whole, mountain air has an advantage over the air of inland plains, and this seems to increase to a certain extent with increasing elevation. In many elevated districts putrefaction sets in much more slowly than on plains, and this is particularly striking in winter, when in the High Alps of Europe the ground is covered with snow, and thus organic emanations cannot rise from the ground and inorganic dust cannot form. It might be objected that it is merely the direct effect of low temperatures which prevents decomposition and permits meat to be dried and preserved in the open air, as is the custom in the mountain valleys of the Grisons; but the experiments made by Pasteur on the Mer de Glace and in Chamounix point to the fact, that besides the direct effect of cold there must yet be other factors. This author ('Annales de Chimie et Physique,' vol. lxiv., 1862) found that the air on the Mer de Glace was free from fermentative substances, whilst the atmosphere of the neighbouring village of Chamounix contained them in large quantities. In winter, when the Swiss mountain valleys are covered by snow for four or five months, the air over them must be under conditions similar to those over the glacier, owing to the absence of fermentative substances. In a paper read in 1869 before the Med. and Chir. Society ('Trans.' vol. lii.) we drew attention to this circumstance, and more recently Burney Yeo and Clifford Allbutt have used the term 'antiseptic' in reference to the air of elevated regions. I should prefer the term 'aseptic,' that is, free from substances causing fermentation or decomposition.

As regards the electrical conditions, we have but little accurate knowledge; it seems, however, that thunder storms occur more frequently in a zone of medium elevation (between 3,000

and 6,000 feet in the Alps) than in the higher or lower zones. Becquerel and Breschet's experiments on the St. Bernard and other places point to a greater predominance of positive electricity. The lower temperature in mountain regions might likewise be mentioned in support of it, and perhaps also the sensation of increased energy which is experienced by most persons up to certain elevations.

Electricity.

Generally speaking, the air is more in motion in mountain regions, being exposed not only to the general, but also to the local winds, particularly to the daily periodical, that is, mountain or valley winds. There are, however, the greatest differences, according to the aspect of the place and the protection afforded by adjoining eminences, so that while some places are well sheltered others are very windy, the summits of mountains belonging, with few exceptions, to the latter category. It is an important characteristic of many mountain valleys in the European Alps that in winter they are comparatively free from winds, because, on account of the covering of snow, the air is not heated, and local currents are, accordingly, wanting, whilst high mountain chains protect these valleys to a certain extent from the more general winds. Such is the case, for instance, in the well-known valleys of the Upper Engadine and in Davos, where in this respect the difference between summer and winter is very great and quite in favour of winter.

Movement of the air.

The ground is at most places rocky, or covered with but a moderate quantity of mould, and is mostly dry at the tops and slopes of the mountains, quickly drying up even after an abundant rainfall, whilst it is damp only in gently sloping valleys and in gorges. Generally speaking, it may be said of the places available as summer health resorts that the *soil is not damp.*

Condition of the surface.

The covering of the ground at moderate elevations in the European Alps consists mostly of grass and woods, with a prevalence of pine trees; in the higher regions all deciduous trees disappear gradually, and higher up even the pines, whilst only low shrubs are met with, such as rhododendrons and short grass, with an abundance of flowers, which, in variety and intensity of tints, far exceed those of lowlands, so that the same species have quite a different appearance in the High Alps compared to

those in the meadows of plains. Shepherds who have gained experience in level countries, and also in the mountains at moderate and high elevations, say that the grass of their mountain valleys and slopes is more aromatic than the grass met with on low grounds.

Characteristics of mountain climates.

The chief characteristics of climates of high altitude, or mountain climates, particularly as regards the High Alps of Europe, may be summed up as follows:—

1. Diminished barometric pressure; rarefaction of the air.

2. Lower temperature of the air, accompanied by great intensity of solar radiation, being in winter much in excess of the amount met with on lowlands, whilst the air is very little heated by the hot rays of the sun. Low temperatures in the shade and very low night temperatures, particularly during the cold months.

3. Remarkable dryness of the atmosphere, whilst the mean amount of rain or snow is rather considerable.

4. Much motion of the air in summer, while in winter there is but little wind in sheltered mountain valleys covered with snow.

5. Great purity of the air as regards inorganic and organic admixtures and miasms, especially during the period of permanent snow (aseptic air).

6. Increased action of light.

7. Excess of ozone.

8. Probably an increased amount of positive electricity.

9. Drier soil.

Physiological effects of mountain climates.

The physiological effects of climates of high altitude, or mountain climates, have been even less accurately investigated than their physical conditions, and it is more difficult to summarise them briefly. We cannot enter into a discussion of the effects which each physical agent has on the various organs, and it seems to be more to the purpose if we make a few general remarks in reference to the behaviour of the principal organs and bodily functions under the influence of mountain climates.

The *skin*, chiefly owing to the diminished pressure of the air and the greater heat of the sun, receives an increased amount of blood, the nutrition of the blood vessels, the nerves, and of

the elastic tissue is improved and the whole organ is strengthened by residence for some time in mountain climates. As a result, most people experience a greater power of resistance to influences causing chills. Perspiration is increased in the mountains, owing to the dryness of the air, although it rarely shows itself in drops or saturates the clothes, because the sweat evaporates more rapidly, in consequence of the increased circulation of the air, its greater dryness, and the increased temperature of the surface of the skin. The increased elimination of watery fluid is always attended by a greater loss of solid and gaseous substances.

Action of the heart.

The contractions of the heart are at first more or less accelerated on removing from low-lying places to mountain climates, but in most cases they return to their normal number after a residence extending from a few days to several weeks. It was formerly the accepted opinion that the frequency of pulse increases in a corresponding ratio with the elevation above the sea, and we were ourselves led to this view by a number of observations made on persons who had not been long in the Alps, as the pulse in most of these cases was more frequent for a few days after arrival in higher regions, compared with the ordinary standard on low ground, and a kind of proportion seemed to exist between the degree of altitude and the increase of pulsations. However, further observations on forty-four persons who had spent periods ranging from twelve days to six months in mountain climates have led us to the following results: In thirty-two cases the frequency, under similar conditions, was hardly altered, whilst in ten cases there was an increase of from 5 to 18 per cent., and in two cases a decrease of from 8 to 15 per cent.[1] In forty-eight healthy inhabitants, mostly guides or medical men and their families, persons from fifteen to fifty years of age, the frequency ranged between 54 and 72, or 66 on an average; it was, therefore, not higher than among inhabitants of level countries.

[1] Dr. C. T. Williams, in his paper on 'The Treatment of Phthisis by Residence at High Altitudes' (*Transactions of the International Medical Congress*, 1881), refers to observations made by Dr. Ruedi on 117 phthisical patients who had spent six months at Davos, showing an increase of pulse in 18 (15 per cent.), a decrease in 90 (77 per cent.), and a stationary condition in 9 cases (7½ per cent.). —*Tr.*

A point which has not yet been sufficiently examined is the *force of the contractions of the heart* and of the pulse. Observations ought to be made extensively by means of the sphygmograph or cardiograph. The author's impression was, that in the greater number of those who for the sake of health had spent a long time in the High Alps, the force of the pulse and of the heart was raised; however, such observations without taking accurate measurements have only a limited value.

The objection that hæmorrhage takes place more easily on heights does not apply to such elevations as are available for the treatment of invalids. The experience of physicians who live in mountainous regions shows that hæmorrhage is not more frequent than on low ground, and that, on the contrary, hæmorrhage from the lungs is decidedly rarer, whilst even bleeding piles and uterine hæmorrhages occur less frequently. The cases of hæmorrhage described by Saussure and others were observed after exertion and at greater elevations above the sea. Boner, of Davos, maintains that the visible veins, and also varices and piles, collapse under the influence of a long residence in the mountains.

Respiration.

The conditions of respiration on heights compared with those obtaining on low ground have given rise to a great diversity of views. As regards the *number of respirations*, the theory (apparently supported by facts) was started that it must be greater on heights, because a given volume of air contains less oxygen on heights, owing to the rarefaction of the air; but this is not in accordance with fact. Though our own observations on forty-two persons resulted (in 94 per cent.) in an increase by two to five respirations during the first days after removal from low ground to heights ranging from 4,000 to 7,500 feet, careful observations made on thirty healthy, or almost healthy, individuals who had spent from two to twenty weeks on heights, showed in 82 per cent. no alteration in the frequency of respiration, in 12 per cent. an increase of from two to four respirations, and in 6 per cent. a decrease of two or three respirations. The average number was on low ground fourteen per minute, and on the heights 14·4.[1] The average taken of

[1] Among Dr. Ruedi's 116 cases of phthisis in various stages who passed six months at Davos, ninety-five (80 per cent.) showed at the close of their visit a

thirty-eight permanent inhabitants of the heights was 14·2, or very much the same as among the inhabitants of lowlands who were the subjects of our observations. Boner even maintains that in the inhabitants of the High Alps the respiratory movements are slower and deeper, and the pulse of a corresponding nature.

As regards the quantity of the air respired on heights and on low ground, Lombard ('Climat des Montagnes,' third edition, 1873, p. 51) cites the fact, based on observations by Léon Coindet, that in Mexico, at an elevation of 7,350 feet above the level of the sea, the average is 36·6 cubic inches, while on the seashore it amounts to 30·5 cubic inches. More extended observations ought to be made on this subject. In contrast to this, Marcet found that a decrease in the amount of air expired took place at elevated stations, it being less on the Peak of Teneriffe (at about 10,000 feet above the sea) than at the coast of the island; and similarly in the Alps, at elevations of 13,000 feet, compared with the level of the Lake of Geneva, Lombard gives one of Professor Soret's tables, out of which we will cite some figures :—

Quantity of Oxygen in Centigrammes contained in a Litre of Air at a Temperature of 32° *F.*

Barometric Pressure in Millimetres	Altitude in Metres	Amount of Oxygen	Percentage of Oxygen, the Quantity at the Sea Level being taken as 100
760	0	0·29888	100
704	500	0·28079	94
670·5	1,000	0·26369	88
591	2,000	0·23242	78
521·5	3,000	0·20509	69
460	4,000	0·18090	60

From this table Lombard deduces that an adult receives in the day 348 grammes of oxygen less at the elevation of Mexico than at the level of the sea, and agrees with Jourdanet, who, in his well-known work on Mexico, and the influence of high alti-

decreased rate of respiration, six (5 per cent.) an increased rate, and sixteen (14 per cent.) no increase or decrease. Dr. C. T. Williams explains this decrease in the number of respirations in most of the patients by the fact that in them the chest wall gradually expands, enabling the individual to take deeper breaths, and therefore rendering a smaller number sufficient.—*Tr.*

tude on the bodily functions, expresses the opinion that at elevations like that of Mexico the body is supplied with a reduced quantity of oxygen (*la diète respiratoire*). It may, however, be objected that in ordinary respiration at low levels only part (about 25 per cent.) of the oxygen contained in the air is used up, and that on heights ranging from 3,300 to 10,000 feet, which are available for the treatment of invalids, the air holds a considerable excess of oxygen compared with what is absorbed by the blood. However, putting aside the different theories, the valuable investigations of Frankland and Tyndall show that candles in a sheltered position burn quite as quickly at the summit of Mont Blanc (15,748 feet) as at Chamounix (about 3,280 feet). These investigators show, moreover, that the combustion is more complete on heights, and they explain this by assuming a greater mobility in the particles of oxygen. We cannot here enter at greater length into their instructive and interesting views and conclusions, referring the reader to their well-known works (Frankland, 'Philosophical Transactions,' vol. cii. p. 629, and 'On the Influence of Atmospheric Pressure on Combustion,' in 'Experimental Researches in Chemistry,' p. 863, 1877; Tyndall in his classical lectures on 'Heat considered as a Mode of Motion,' which are of particular interest to physiologists).

We thus learn that we must not be too rash in explaining vital processes by means of conclusions based on chemical or mechanical laws. Moreover, the general appearance of the inhabitants of the Upper Engadine, and of several yet more elevated places in the Grisons, shows that their state of health is not in any way affected by a supposed want of oxygen, and the same holds good for the inhabitants of the places in Colorado, in North America, on the slopes of the Rocky Mountains, which have come so much into favour for the climatic treatment of invalids. More accurate observations are greatly wanted on the relative proportions of oxygen consumed, and of carbonic acid given out, in breathing on heights compared with low levels. Marcet has furnished some very valuable contributions in his observations on the function of respiration at various altitudes on the Island and Peak of Teneriffe ('Proc. Roy. Soc.,' 1879) and in the Swiss Alps. He found that the weight of carbonic acid expired by him near the top of the peak and at the seaside

differed but little, although he, as well as his guide, gave out more of this gas at the two highest stations, at about 11,222 feet above sea level, than at either 7,090 feet or the seaside, the excess being about 1·2 per cent. In the Alps, the excess of carbonic acid expired at 13,500 feet over the amount given out near the Lake of Geneva at 1,230 feet was considerably larger, amounting to 15 per cent. The slight difference on the Island of Teneriffe is, according to Marcet, accounted for from the high temperature of the air prevailing on the mountain, high temperatures causing, as it seems, an increase in the production of carbonic acid (see p. 23). Marcet considers this increased production of carbonic acid on heights to be of particular importance as regards the explanation of their therapeutic effects, and he is of opinion that at great elevations above the level of the sea the excretion of carbonic acid is facilitated.[1]

The diminished quantity of watery vapour contained in the air of elevated regions greatly influences the functions of the lungs, the body thus losing a large amount of moisture, and, as we may well assume, of gaseous substances with the aqueous vapour. This considerable evaporation of fluid must be attended by a considerable degree of abstraction of warmth, and to this must be added the loss of warmth caused by the heating of the generally cooler inspired air. These two factors, the abstraction of moisture and of warmth, affect first and principally the lungs, and may have a drying and cooling effect on the final ramifications of the bronchi, and influence morbid processes in these parts accordingly.

It is very probable, as maintained by Waldenburg, Boner, and others, that on heights more blood is determined to the lungs than to the skin, chiefly owing to the diminished pressure of the air, perhaps also because more blood is conveyed to the lungs in consequence of increased evaporation. We may sup-

[1] More recent experiments by Marcet (1880) have given further confirmation to this fact. While he, near Geneva, was expiring a mean of 0·538 gramme of carbonic acid per minute, he only gave out 0·435 gramme on the Col du Géant (11,030 feet above sea level), or 19 per cent. less; and a young friend of Marcet's, who expired a mean of 0·776 gramme of carbonic acid near Geneva before leaving for the Col, expired only 0·609 gramme on the Col, or 21·5 per cent. less. Marcet, *Southern and Swiss Health Resorts*, p. 339.—*Tr.*

pose that this increased influx of blood leads to an improved state of nutrition in the lungs.

Nearly all observers point to the greater expansion of the chest in the inhabitants of elevated districts, and some of them have even published cases of healthy subjects and invalids in which a protracted stay at mountain stations led to an expansion of the chest. The author himself has notes of fourteen young persons who, although having narrow chests, were not actually consumptive. In these an expansion of the chest by ⅜ to one inch could be established after a residence in a high mountain climate ranging from three to twelve months. In explanation of this it seems natural, with Boner, to assume that the elasticity of the lungs, increasing in rarefied air, makes inspiration more difficult, and thus brings the respiratory muscles more into action. That the diminished amount of oxygen does not offer a sufficient explanation, results from what we have said before.[1]

Expansion of the chest.

Most healthy persons, and those who are affected to a slight extent only, experience an increase of appetite at elevations up to 6,000 or 7,000 feet. After a more lengthened residence the desire for food returns to the normal standard in the *healthy subjects*, unless considerable increase of outdoor exercise, or low temperatures, should come into play; this at least is the impression we gained by questioning many intelligent persons who could well observe themselves, although most of the resident doctors and hotel keepers say that more food is consumed on heights than elsewhere. *Invalids*, on the other hand, exhibit various conditions. In a considerable number of delicate individuals the appetite fails from the beginning of a residence at elevated places, even if these range only from 4,000 to 5,000 feet in altitude, and this

Appetite.

[1] Dr. C. T. Williams has published the results of careful observations made by him on twenty-two cases of consumptive patients, who were sent by him to mountain climates (with one or two exceptions to Davos), and spent there periods of from two to eighteen months, the average of stay being six months. An expansion of the chest was proved in nearly all the cases, the increase varying from one to three inches at different levels of the chest wall. Williams holds that this result is mainly due to the following changes taking place: (1) hypertrophy; a more complete development of certain portions of healthy lung tissue; (2) emphysema of other portions, specially of those in the neighbourhood of the consolidations and cavities *l. c.*—*Tr.*

want of appetite even develops into a positive aversion to food. In most cases a reaction takes place shortly, and the appetite gradually increases, till it exceeds the normal, remaining so for a long period, whilst in others the aversion to food continues, and may even increase so much that it is necessary to send the patient to a lower and warmer region. This state of things seems only in a limited number of cases to depend on mere rarefaction of the air, and thus to be related to mountain sickness (*mal de montagne*). In the case of most patients, it is due to the combined effects of different influences, such as low temperature, increased waste of substance, and greater demands on the power of adaptation in its different relations, and seems to correspond with the observation that many delicate individuals begin to flag whenever the temperature becomes low, and experience sensations of hunger in summer only, when they display their greatest energy. On the other hand, the greater number of those affected to a slight extent only, if endowed with a certain degree of energy of functions, experience, like the healthy, an increase of appetite from the beginning, the increased introduction of food causing an improvement in sanguification, and in the nutrition of the organs, and thus a more lasting desire for food combined with an increase in the power of assimilation. In them, in contrast to the healthy, the appetite does not return after a short time to what it was whilst they were living on the plains, but remains permanently, or at least for several months, higher in the mountains than on the plains.

Improved sanguification and, combined with it, *improved nutrition* should be noted as additional physiological effects.

Increased energy of nervous and muscular power is likewise frequently seen to take place at mountain stations in the healthy and those but slightly affected.

Sleep is less disturbed in most persons, whilst in others it is interrupted by dreams and considerably shortened in duration. This disagreeable symptom disappears mostly after a few days, but in other cases, where it is prolonged, removal to a lower elevation may become necessary. We must, however, bear in mind that the *kind of sleep* gives rise to differences in its effect on the organism; that a short period of sound sleep has

the same, or even a better, effect than a longer period of less sound sleep under different conditions; and that in the case of many persons sleep at moderate elevations seems to have a much greater power, so that here five to six hours suffice for them, whilst at low levels they require eight hours. In many individuals who sleep badly at low-lying places, and especially at sea, mountain air acts as an excellent hypnotic, and this is particularly the case in literary and business men.

Tissue change is probably increased in healthy persons and also in invalids; accurate and detailed investigations on this important subject are, however, wanting.

Summary of the physiological effects.

The physiological effects produced on invalids may be summed up as follows:—

1. Increased *action of the skin*, improved nutrition and better tone of the skin.

2. Probably increased tone of the *heart*, and of the contractile fibres of the vascular system, accompanied by greater frequency of the heart's action at the beginning, but a return to the individual average after more prolonged residence, with greater force of the contractions, and acceleration in the progressive motion of the blood.

3. Increase in the number of *respirations* at the beginning, and return to the normal number after more prolonged residence, whilst the respirations probably become at the same time deeper. The respiratory muscles are strengthened, and probably also the elastic fibres of the final ramifications of the bronchi. Increased determination of blood to the lungs.

4. Generally the quantity of *watery vapour* emitted from the lungs is considerably increased, and *carbonic acid* is given off more readily and in larger quantities.

5. In most cases the *appetite* is increased either for a time or permanently, and more food is assimilated.

6. Consequently, more blood is formed and the different organs are better nourished.

7. The nervous and muscular systems are stimulated to greater activity.

8. Sleep is mostly improved.

9. Tissue change is probably increased.

As regards the *prevailing diseases* of mountain regions,

Lombard has supplied some valuable information, and of later publications we would mention as particularly valuable the prize essay of Dr. Ludwig, of Pontresina, on 'The Upper Engadine' (Stuttgart, 1877). Compared with low-lying districts, the following are the more prevalent *causes of death*: inflammatory affections of the respiratory organs, apoplexy and paralysis, meningitis, 'dropsy,' peritonitis, and debility from old age; on the other hand, phthisis and scrofulous affections figure much less. The most common *diseases* are bronchitis, pneumonia, pleuritis, bronchial and intestinal catarrh, conjunctivitis, rheumatic and neuralgic affections, and also certain forms of anæmia and cardialgia occurring chiefly in women, and caused by improper food and unhealthy ways of living; whilst chronic pneumonia, phthisis, hæmoptysis, scrofulous diseases, hæmorrhoids, intermittent fevers, and other malarious affections are decidedly rare.

Therapeutic applications.

The various climates comprised in this group differ greatly in their effects according to altitude, latitude, general aspect, configuration of the ground, &c.; hence we can say only in quite a general way, that mountain climates have a bracing effect, that they stimulate most of the functions, and that, in the treatment of disease, they exercise an invigorating action, but that in order to produce these effects they require a certain integrity and reactionary power of the constitution. With this proviso, we may say that mountain climates are indicated in many forms of want of appetite and gastric disturbance, arising from insufficient exercise in the open air and deficient absorption of oxygen, and leading to anæmia, hydræmia, chlorosis and cardialgia; in chronic catarrh of the fauces and the bronchi with increased expectoration; in anomalies of nutrition and blood formation produced by the malarial poison; in many cases of sluggishness of the abdominal circulation, tendency to hæmorrhoids, and some forms of hypochondriasis; in many nervous affections associated with anæmia or general debility, such as neuralgia, the milder hysterical conditions, and polyuria; in most cases of asthma, unless they are dependent on, and associated with, emphysema, or organic disease of the heart and the arteries; in many cases of sleeplessness caused by overwork or general debility, without mental

excitement; in cases where the tone of the skin is lowered and abundant sweating occurs on every exertion; where the development and the expansion of the thorax are incomplete; in phthisical tendency, and in many conditions of phthisis which we will presently discuss more in detail. Scrofulous affections are likewise benefited by mountain climates, but in the majority of these cases sea climates are to be preferred.

Contra-indications.

Of conditions to which mountain climates are, as a rule, not suited, we would mention most cases of organic heart disease, and of diseases of the arteries, although this rule is subject to some exceptions. In moderate dilatation of the heart, and deficient power of this organ with or without valvular disease, residence at moderate elevations up to 1,500 or 2,000 feet is often attended by favourable results, which are mostly better than those obtained in sea climates. Several cases of aortic aneurism have come to our notice where this was likewise the case; indeed, Archibald Smith had a man under his observation for a long time who, whenever he was at Lima, that is, near the sea, and where he finally succumbed to his sufferings, had shortness of breath on the slightest exercise, whilst in the mountain valleys of Peru (Tarma and Jauja), at an elevation of nearly 10,000 feet above the level of the sea, he was able to do military service. Generally speaking, it may be said that atheroma of the arteries, either of senile or pre-senile nature, and allied affections contra-indicate residence at higher elevations. Cases of chronic catarrh with considerable dilatation of the bronchi and emphysema allow only of very moderate elevations, and generally do best at the sea and under the condensed air treatment. Cases of epilepsy are mostly injured in climates of high altitude, but experience on this point is as yet limited. Rheumatic affections and convalescence from rheumatic fever are unsuited. Considerable degrees of constitutional weakness, with inability to bear wind, cold, and change of temperature, are likewise unsuited for longer residence at high altitudes. Generally speaking, mountain air is not suitable to persons advanced in years, nor is it to tender infants; both these classes do much better at warm seaside places. Practical hints on the pros and cons of residence at the sea, or on mountains, and on their

relative value, are to be found in an excellent article by Burney Yeo on 'Sea or Mountain' ('Health Resorts and their Uses,' 1882).

Phthisis and climates of high altitude.

The treatment of pulmonary phthisis by climates of high altitude has recently excited such general attention that we must go at greater length into this subject. The historical part has been well given by Küchenmeister and Thomas; therefore we will only mention that on the coast of Peru, where consumption is frequent, and generally takes a rapid course, according to Archibald Smith, the usual and only successful treatment has for a long time consisted in sending such patients to the neighbouring mountain valleys of the Andes, at elevations of about 10,000 feet above sea-level, and that, as regards Europe, this treatment has come into use about twenty years ago. It was Brehmer who first employed it extensively at Görbersdorf, in Silesia, by making use, at the same time, of dietetic, hygienic, and hydrotherapeutic methods. He thus had many good results, and although Görbersdorf cannot be ranked among the mountain climates proper, the experience of Davos and some other places has fully confirmed the correctness of Brehmer's principles.

We cannot enter on the pathology of consumption, but we must always bear in mind that in these conditions we have to deal not only with changes in the lungs, but with defects in the whole organism, and particularly with hereditary or acquired weakness of innervation and circulation, or of digestion and nutrition; frequently also with the effects of living in impure air, or of the habit of breathing superficially, owing to deficient exercise and depression of spirits. In addition, we have constantly to consider the nature of the constitution of each invalid, whether this is erethic or torpid, both as regards the mind and the body. As regards the local affections, we assume that, however individual cases may differ as to etiology, stage of disease, or the presence of different stages and processes in different parts of the same diseased organ, in all cases we have to deal either with superficially inflamed or irritated, or with actually suppurating surfaces, or with abscesses and sinuses. Such affections are often associated with simple inflammatory, purulent, or septic fever; and, when occurring on external parts, such as the skin

or the genital organs, heal with difficulty, or even spread widely in impure air. Hence in treating pulmonary affections we must always have regard to the processes met with in the case of external wounds after operations, and in surgical or gynæcological practice generally; and we must also give attention to the remedies considered by the surgeons as necessary in the treatment; and, first of all, to the circumstance that pure air is the chief point, and that if the air be impure, in many cases the slightest wounds lead to protracted ulceration, to sinuses, and actual pyæmia and septicæmia. These points are, in our opinion, important ones, whatever views we may hold as to the nature of tuberculosis, whether it be an infectious disease, produced by spores or germs, whether every form of phthisis be associated with these organisms or not,[1] or whether phthisis arises by the breathing of used-up air. Were it possible to treat locally the open sores or ulcers in the lungs, the conditions would be of a much simpler nature, although even Lister and other surgeons find it often difficult to disinfect a once infected wound.

In a conversation which I had on this point with Brandis, of Aix-la-Chapelle, my attention was drawn to the fact that wounds heal more readily the more air is brought in contact with them, and that drying up and compression advance the process of healing considerably. It is, indeed, very probable that *more air is inspired* at high altitudes, and we have already pointed out the circumstance that by the *drier* air of elevated regions much water is abstracted from the lungs, and that this favours exsiccation. We have also seen that *colder* air is inspired, and that, as this becomes heated, the surface of the lungs must give off heat; and, further, that this loss of heat is augmented by the evaporation in the lungs of a large quantity of fluid. Hence we have *increased ventilation* (G. von Liebig), *exsiccation*, and *refrigeration*, that is, *local antiphlogosis*. As regards *compression*, even this element is not wanting. It is well known that the thorax frequently expands, chiefly on the affected side, and that this process is associated with an enlargement of pulmonary vesicles, thus mostly producing an emphysematous state round the diseased portions of the lungs.

[1] This was written before Koch's discovery of the invariable presence of bacilli in tubercular matter.—*Tr.*

Hence it may be supposed that in such cases the morbid tissue undergoes compression, and the bringing into contact of the sore surfaces is thus promoted. As regards exsiccation, it stands to reason that this affects also the morbid products already formed; that the latter become partly deprived of water, that thick matter dries up, that caseation or calcification takes place, and that the tendency to absorption, and to pyæmic infection, and also to acute miliary tuberculosis, being closely related to the latter, is diminished. Further observations are necessary in order to show whether, after a complete or partial cure had been effected in cases of phthisis by mountain climates, chalky masses are more frequently met with in the dead body. The author himself having had the opportunity of making eight post-mortem examinations on subjects who, by residence in elevated regions, had temporarily or permanently been cured of phthisis and had later on succumbed either to this disease or to other affections, has found chalky masses in four cases. Several patients of his who have passed through the same treatment expectorate at times chalky masses.

The processes of exsiccation, refrigeration, and compression are assisted by increased determination of blood to the lungs, this being a further effect of mountain climates, and, associated with it, by improved nutrition of the lung tissue. The greatest factors in the cure are, however, the purity and the aseptic condition of the air, the importance of which, as regards ordinary wounds, has been pointed out by Lister, Volkmann, Nussbaum, Brandis, Maas, and almost all surgeons of recent times. As regards the general condition of the patients, we draw attention to what we have said above concerning the increase of appetite, the improved nutrition, the rise in muscular force, the invigoration of the nervous system, and the acceleration of tissue change taking place in constitutions suitable for these climates.

Formerly great stress was laid on the so called 'immunity' against phthisis met with at high altitudes, and the author himself used to think more of this immunity than corresponds with our present knowledge. Investigations on this subject, and the results of the commission of Swiss naturalists and physicians, have shown that, although consumption is much

rarer in high Alpine regions than on plains with towns and factories, it is not entirely absent, and that even many cases of consumption occur in industrial districts situated at high altitudes, thus showing that non-hygienic conditions and overcrowded rooms will do harm even in high Alpine valleys otherwise healthy. Ludwig, of Pontresina, has also met with several cases of undoubted phthisis occurring in the Upper Engadine.

We will now briefly consider the different conditions in which climate treatment by high altitudes may be indicated.

1. The *disposition to phthisis*, whether hereditary or acquired. The conditions comprised in this class are so well known, and so various as regards causes and symptoms in individual cases, that we need not enter upon them at greater length.

2. Cases of *catarrh* or *pneumonic infiltration of the apices* of different nature, with or without flattening of the upper parts of the chest, are, as a rule, suitable for mountain climates. There are, however, some exceptions, which will be considered under the contra-indications.

3. Cases in which *pneumonic exudation*, either of the upper or lower lobes, has been incompletely absorbed, and consolidation with chronic catarrh still exists. The presence at the same time of great weakness of the heart, senility, or Bright's disease are, however, contra-indications.

4. *Chronic bronchial catarrh* of the lower lobes, unless the above-named complications or emphysema be present. The quantity of expectoration often decreases rapidly under the drying influence of the aseptic air.

To effect a cure in cases comprised under either of these four groups, generally requires a very long time, unless the affections be of quite recent origin, and the constitution of the patient still vigorous. If the disease is of old standing, or if wide areas of the lungs are implicated, the treatment must extend not over months only, but over several years; and even then changes are often left behind, as regards the three last groups, which make it necessary that the invalids observe strictly, and for their lifetime, an appropriate regimen, and which, particularly during the unfavourable seasons, require constant attention to climate conditions.

5. In cases of *pleuritic exudation*, unless it be of purulent

nature, absorption takes place more easily; and probably the increased loss of water and the stimulation of tissue change play some part in that. In such cases the residence in the Alpine climate ought to be a very long one, for even after the patient feels quite well again, and after complete resorption of the effusion has taken place, much time passes before complete distension of the lung can be arrived at. This is much promoted by the deep inspiratory movements which are induced by high altitudes, especially if methodical exercise is resorted to.

6. *Caseous deposits* (or rather the supposed existence of such deposits), unless they are very extensive, are favourably influenced in Alpine climates, and it is likely that they dry up and are partly absorbed, or that softening is retarded and they calcify more easily. In such cases, after comparatively good health has been enjoyed for years, acute tuberculosis sometimes appears rather suddenly.

7. The presence of *cavities* does not in itself contra-indicate a residence at high altitudes, provided that the destruction of lung tissue be not excessive, and circulation and production of heat not too much interfered with, or that the morbid process be not quickly advancing combined with high temperatures. The author himself had occasion to observe gradual contraction and probable closure of cavities in five cases where their existence in the upper lobes had been diagnosed by several physicians. These cases occurred in patients between nineteen and thirty, of rather torpid constitution and with abundant expectoration, who had either very little fever or only passing feverish attacks associated with fresh catarrhs.—The presence of several large cavities, whether originating as the result of abscess of the lung or of dilatation of the bronchi, mostly contra-indicates mountain climates.

8. Uncomplicated chronic hoarseness, if produced only by catarrh and slight swelling of the vocal cords and their surroundings, attended by catarrhal secretion, without violent hacking cough and without the complications pointing to the existence of tuberculosis or advanced lung mischief—that is, simple *laryngeal catarrh*—is favourably influenced by mountain climates, whilst the conditions comprised under the term 'laryngeal phthisis' are unsuited.

9. *Abundant night sweats*, if dependent upon the general weakness caused by the progress of the disease, or if caused by deficient tone of the skin, are frequently seen to disappear after short residence in high Alpine regions, owing to the augmented evaporation by the lungs, the better tone of the skin, increased ingestion of food, and improved nutrition generally. Even where the night sweats attend advanced lung disease which cannot be cured by the mountain climate, they mostly decrease considerably.

10. The *feverish symptoms* that accompany phthisical conditions are too varied to allow short and comprehensive indications to be laid down. Speaking quite generally, it may be said that if they have a pyæmic or septicæmic character, being intermittent, with free, or almost free, intervals, the climate of elevated regions, together with a suitable dietetic and hygienic treatment, mostly lessens them, and gradually even makes them disappear altogether; if the fever is, however, continuous, and thus denotes the existence of inflammatory and quickly advancing processes, these climates more rarely exert a favourable influence. Still it must be admitted that nothing certain can be said beforehand, for sometimes most favourable changes take place against our expectations, in cases which were considered not suitable for mountain climates. As a result of experience the rule may, however, be laid down that persons who have a tendency to feverish attacks and show rise of temperature for days and weeks with every catarrh, and even from errors in diet or mental excitement, or bodily exercise beyond their powers (that is, 'erethic' persons), are not adapted to mountain climates even if the pulmonary affection be quite unimportant; whilst those persons who, though suffering from extensive lung mischief, have either no fever, or fever but for a short time on the appearance of fresh inflammations (the so called 'torpid' constitutions), do very well in mountain climates.

11. The *circulatory functions* are closely associated with the degree of disposition to feverish symptoms. Though an habitually weak and frequent pulse does not in itself exactly contra-indicate mountain climates, still great and lasting frequency of pulse, if it accompanies every slight catarrh or mental emotion or moderate exertion, mostly points to a tendency to

pyrexia and to a constitutional disposition in which slight disturbances are apt to lead to extensive affections not easily arrested, and in which the harmony of the functions is easily disturbed, but only with difficulty reinstated. Persons, on the other hand, in whom the frequency of pulse is generally moderate, and in whom it is only slightly raised by inflammatory complications, and soon returns to the normal standard, offer a comparatively favourable prognosis for the influence of mountain climates, even if the local affections be more extended.

12. A tendency to *hæmoptysis* was formerly considered as a contra-indication, and is regarded as such by some authors even at the present time, but the view held by us in former communications that hæmorrhage, instead of being more frequent at high Alpine resorts, is in reality of rarer occurrence, is in accordance with the opinions expressed by Spengler, Lombard, Williams, Unger, and Ruedi, and has been further confirmed by the publications of Solly and Denison in Colorado. The author is in possession of notes on this point concerning 62 consumptive invalids residing in mountain climates and 88 who lived in low-lying health resorts. The 62 invalids of the first class spent altogether nearly 600 months at high altitudes, and the 88 of the second class passed almost the same time at the low-lying stations. Among the former, hæmoptysis occurred in 11 cases, and 16 attacks took place in the 600 months; among the latter 36 suffered from hæmoptysis, and 62 attacks occurred during the whole time of treatment, extending over nearly 600 months: hence hæmoptysis was four times more frequent at low-lying places, compared with high altitudes. The reason of this can almost with certainty be assigned to the diminished tendency to suppuration, to septic states, and to rapid destruction of lung tissue at high altitudes, and is analogous to the fact, as communicated to us by Brandis in Aix-la-Chapelle, that after operations, before the antiseptic method had come into general acceptance (particularly during the late Franco-German war), hæmorrhage occurred much more frequently than at the present time with the observance of antiseptic precautions. In cases with a tendency to hæmoptysis, even in the absence of direct phthisical symptoms, we have re-

peatedly recommended a long residence at high altitudes, and, as the result showed, quite rightly.

13. Cases with a tendency to *diarrhœa*, if the latter does not proceed from tubercular ulcers, but from simple catarrh, or is associated with deficient tone of the skin or a weak digestion, are generally benefited by residence at high altitudes.

14. Cases complicated with *asthma* are not unsuited to mountain climates, particularly if the asthma is of the pure spasmodic kind, or if dependent on chronic bronchial catarrh, and if emphysema, bronchial dilatation, and heart disease be absent. Several cases have occurred to us in which removal from the English sea coast, or the Riviera, to moderate or high elevations in the Alps, led to a prompt disappearance of the asthmatical complication.

The *contra-indications* have been partly mentioned in treating the above points, partly also in our general remarks on the effects of mountain climates. We must, however, once more recur to the point that the frequently expressed opinion that mountain climates suit all cases in the first stage of phthisis is subject to the important restriction that the so called *erethic* persons who show feverish symptoms on the slightest cause, with irritable heart, constant frequency of pulse, and inability to bear cold or slight changes of temperature, should only in exceptional cases be sent to mountain climates, and, if so, must use great care. Even Spengler in Davos, who formerly advocated the use of mountain climates in almost all cases of phthisis in the first stage, says in one of his latest publications ('Bericht über die Saison rätischer Bäder und Kurorte in 1877') that for persons of an erethic constitution mountain climates are peculiarly unsuited, and 'such persons should not be sent to Davos even if suffering merely from catarrh of the apices.' Cases with *advanced and still active phthisis*, in which mostly both lungs are affected, should likewise not be sent to the mountain health resorts of Europe, though these be easily accessible. In such cases there is indeed little to be done anywhere, but the invalids are much more at their ease in warm climates, such as the Riviera, or at their own homes, or mild places near them, where the nursing and the intercourse with their friends and relatives is easier to be had. Should Davos, or other mountain

stations, be particularly insisted upon by the patients and their friends, as is frequently the case, a clear exposition of the facts ought to be given to them without reserve. In a conversation which I lately had with Ruedi, of Davos, this physician, in mentioning other contra-indications, laid great stress on the point of heredity, and expressed the opinion that, even if the lungs were only slightly affected, mountain climates should be avoided in cases where hereditary predisposition was pronounced. However, as this factor is a ground for doubtful prognosis, even if the Riviera or Egypt be selected for climatic treatment, it seems to us that heredity *per se* should not prevent us from sending invalids to high altitudes by way of trial.

It may further be mentioned here in a general way that winter residence at high altitudes, at least as regards Europe, ought to be avoided in all affections which, when the climatic conditions of a given mountain resort are taken into consideration, do not permit much time to be spent in the open air, or confine the patient to his room entirely, and possibly keep him indoors for months. It is, however, erroneous to object, as is frequently done even now by the opponents of this kind of treatment, that at the mountain resorts invalids can but rarely be in the open air. On the contrary, in many of our own cases without fever the days on which the patients were confined to the house were quite the exception, either in the Engadine, or in Davos, or in the elevated regions of the Andes and the Rocky Mountains in America. Even on days on which rain or snow falls, outdoor exercise, with proper precautions as to clothing, is mostly possible for several hours, as, particularly in winter, the air is calm and at most of the health resorts the number of fine days amounts to 150 or more, and that of the moderately fine days to about 100.

It has also been objected that at mountain health resorts colds and other intercurrent affections, such as pleuritis, bronchitis, pneumonia, rheumatic fever, hæmorrhage, or diarrhœa, are more likely to confine the invalids to their rooms than at the warm health resorts; but this view is probably erroneous. In our patients the very opposite took place. We have been in a position to obtain definite data on this point from 40 patients who spent 1,800 weeks at mountain health resorts,

and, on the other hand, from 48 patients who passed 2,620 weeks at low-lying and mostly warm stations, such as the Riviera, Egypt, Algiers, Palermo, or Madeira. The 40 patients of the first class were confined to their rooms by intercurrent affections for 131 weeks, representing 7·3 per cent. of the time of their whole residence, whilst the 48 patients of the second category were kept indoors for 495 weeks, or nearly 19 per cent. This unfavourable condition respecting the warm health resorts is, however, as pointed out above, not to be ascribed entirely to the climate, but in a great part to the imprudences which the patients, unless they are properly superintended, are led to commit by the amenities of the climate and the temptations of social intercourse.

Summary of the author's experience.

More accurate and extensive records have to be published before we can draw definite conclusions as to the effects of mountain climates in the treatment of consumption; and we can only wish that the physicians at these health resorts, in conjunction with those who send the patients, would from time to time publish unbiassed reports on the further fate of their patients. The consultant is frequently quite unable to form an opinion on the result of the climatic treatment, either by personal examination of the patient or by detailed medical reports, and a great many cases thus remain unpublished. Our own observations are, therefore, confined to 75 invalids, who spent 5 months or more in mountain climates, or 1,875 months altogether. Of these 75 patients 18 were cured for a time or permanently, 28 improved considerably, in 14 the result was doubtful, and in 15 the disease made decided progress.

Of the 75 patients 50 were in the *first* stage of phthisis, suffering from either chronic affections of the apices or from the remains of pneumonic or broncho-pneumonic deposits of some extent, or from single or repeated attacks of hæmoptysis. These cases resulted in 17 recoveries, whilst 21 improved considerably, 11 were doubtful cases, mostly becoming worse later on and ending fatally, and 1 case took a rather rapid course towards death.

Of 18 cases in the *second* stage, with softening and com-

mencing excavation, 1 was cured, 5 improved, in 3 the result was doubtful, and in 9 it took an unfavourable turn.

Of 7 cases belonging to the *third* stage, 3 showed decided improvement, in 1 the result was doubtful, and 3 became worse.

This short summary requires some explanation. In speaking of '*cured*' cases we understand cases in which the constitutional symptoms, such as cough, &c., had disappeared for one or for several years, and nothing could be found out by physical examination except the signs denoting cicatrisation. Of the above-named 18 cases of recovery, 7 patients under unfavourable external conditions succumbed later on to fresh attacks of the disease; one of these, after having enjoyed good health for 12 years, suffered a relapse, owing to depressing influences and constant occupation in confined and badly ventilated rooms, being at the same time deprived of sufficient exercise; whilst another patient, after having been well for 18 years, died in consequence of empyema arising in the course of typhoid fever. A further case out of the 18 recoveries was that of a patient who kept well for a good many years, and, whilst exposed to unfavourable conditions of life, had afterwards repeated attacks of severe hæmoptysis, but has now remained free from them for the last two years, and, as he informs me, is in tolerable health and leads an active life in Colorado, in the Rocky Mountains of North America. Of 3 cases we heard nothing during the last few years; whilst 7 cases, several of which were recorded in our paper read before the Medical and Chirurgical Society in 1869 (cases 6, 7, 8, and 10), have up to quite recently been still free from any kind of lung disease.

Amongst the 28 cases which in our statistics appear as '*decidedly improved*,' 5 recovered almost completely later on, whilst 15 have still to undergo climatic treatment with variable results, and 8 succumbed to the disease, some at their homes, some at other places. Improvement of the local symptoms in the lungs, amelioration of the general state, and increase of weight have justified us in using the expression 'decided improvement.'

Amongst the 14 *doubtful* cases no positive improvement had taken place, viz. the local symptoms had not altered,

though the general health mostly appeared somewhat improved; 9 of these cases ended in death some time after; 4 of the patients are alive, but are still invalids, and 1 has recovered almost completely.

Of the 15 cases that '*became worse*' only two passed into the state of stationary and apyretic phthisis, whilst 13 succumbed to the disease later on.

Before we give a short account of the principal mountain stations, we must enter on several points of importance as regards this particular treatment. First of all, as to the duration of the residence, no definite rules can be laid down, for everything depends on the constitution of the invalid and the stage of the disease, also on the way in which the climate affects the patient mentally and physically. In cases of pronounced phthisical tendency, even if the patient be still in the first stage, the climatic treatment should always be continued for several years; and the question whether the whole of this time should be spent in mountain climates, or whether other climates should also be resorted to during a portion of each year, must depend on the nature of the selected place and the condition of the patient. Again, the kind of constitution and power of endurance met with in individual cases must guide us in the choice between warmer or colder mountain climates, provided we are at liberty to choose; and it depends on the power of resistance, and frequently on the temperament of each individual, whether winter or summer be the suitable season for the treatment in mountain climates, or both together. The rule may, however, be laid down that, as regards the Swiss mountains, the time of the year in which the ground is covered by snow is the most suitable for most invalids capable of a certain amount of muscular activity, whilst others do better if they spend the summer season at places of moderate elevation and surrounded by woods.

Duration of residence.

A standing point of controversy, which can hardly be decided as to all cases, is given, as regards the European Alps, by the intermediary periods from winter to spring, and from autumn to winter—the periods when the snow melts and when it commences to lie on the ground. Although the latter period is not a very agreeable one for most invalids, it is much better

for the majority, if they arrive at the mountain station some time before the ground is permanently covered by snow, which event mostly takes place in November. They would, therefore, have to arrive by the end of August or the beginning of September in order to become acclimatised and gain somewhat in strength before the snowfalls take place, which are likely to confine to their rooms those patients who are comparatively delicate and require protection. Much more difficult is the question relating to the melting of the snow, which sometimes extends over several weeks, accompanied by very changeable weather, much moisture, frequent changes of temperature, occasional violent winds, and dampness of the soil. There is no doubt that during this period colds with coryza, cough, and angina faucium take place easily, and that the greatest care must be observed by delicate invalids; on the other hand, the danger may be much lessened by using proper precautions. The physician must decide whether the risks connected with a journey to the Italian or Swiss lakes or the Riviera are greater than those attending prolonged residence in the Alps. There will, however, be many cases in which the inclinations of the invalids—for instance, their desire to have a different vegetation and different surroundings about them—will decide the question.

The objection has sometimes been made that those who recovered from phthisis at mountain stations cannot again live at low-lying places, but this is decidedly not the case. All convalescents from phthisis, at whatever places they may have been cured, will for many years be obliged to live according to strict hygienic rules corresponding to their constitutions. There will always be some risk connected with their return into the climatic and other conditions under which they were living when the disease developed; they will have to pay more attention to air, food, and exercise; and it will depend on the constitution of each patient, and on the conditions under which he has to live at his home, whether and when he may return to it. However, this difficulty is generally greater in the case of those who have made a recovery or were improved at warm health resorts, than of persons who have been hardened by residing at a mountain climate and the treatment followed there.

This would be the place to discuss the additional methods of treatment in vogue at the mountain health resorts, but space does not permit us to go much into details. The cold douches, first introduced by Brehmer, have also been adopted in Davos and Falkenstein; and there is no doubt that, if carefully applied and adapted to the circumstances of each individual case, they may do a great deal of good by stimulating the different functions, producing deep inspirations, and hardening the constitution. The use of frictions with the wet towel, whether cold or but moderately cold, is frequently advantageous as a preliminary measure and suffices in many cases. This kind of treatment is not practised in the Peruvian Alps, thus showing that hydropathy is not indispensable in advantageously utilising mountain climates; and a good number of our own patients did very well at places where douches were not used, although we have always drawn their attention to the importance of cold frictions and baths for strengthening and invigorating the skin. Of even greater importance than douches is the kind of food prescribed to the patients, and in this respect Brehmer and his followers, Unger, Spengler, Dettweiler, Ruedi, and others, have the great merit that they insist on frequent, suitable, and, according to the state of the patient, even abundant administration of food. Wine is considered to be an important factor in the dietary, as regards the mountain stations of Europe, and is daily given in quantities averaging from half a bottle to one bottle and more. It is a fact that many consumptive invalids, with a weak action of the heart and feeble innervation, not only can well support large quantities of wine, but that they take more solid food owing to this stimulant, and that this holds good for mountain climates in particular. Still there are consumptives with whom wine does not agree even in high mountains, and others who get on as well without wine as they do with it, so that every case requires individual attention. The questions with regard to exercise, and the amount of time to be spent in the open air, have been treated above; respecting the latter, as much as possible must be allowed, according to the individual cases, and invalids who cannot move about must have covered terraces exposed to the sun, where they can sit in the open air

Other methods of treatment usual at the mountain health resorts.

well sheltered from winds. The amount of exercise to be taken must be prescribed, and will have to be modified or increased when the patient gains in strength. Every good health resort should possess level and gently rising walks with many resting-places, both suitable ones for winter exposed to the sun and shady ones for summer. The proximity of forests, especially if composed of pine woods, is of great importance, owing to the protection they offer from the sun and winds, and also owing to the modifying effects they produce on the air.

Enumeration of mountain health resorts.

Although there are great differences among the individual mountain stations, we shall not attempt a classification according to their principal characteristics. The simplest and most usual classification according to altitude, and the corresponding attenuation and lower pressure of the air, is impracticable, owing to the fact that places of the same elevation, if situated at different latitudes, and even if under the same parallel of latitude, may differ greatly as to other attributes. It is equally arbitrary to divide them according to their mean temperatures, because no indication would thus be given with regard to the differences in the seasons and the times of the day, the length of exposure to the sun, &c. The moisture of the air shows great differences at each individual place according to the seasons and times of the day, though it would answer somewhat better as a standard for division, as has been partly attempted by Biermann. The nature of the vegetation may be considered as expressing best the character of a given climate, and the division into Alpine and sub-Alpine mountain climates, as carried out by Lombard and others, has many advantages and is well adapted for general purposes; but in the treatment of phthisis the arrangements made for the reception of invalids, and the kind of treatment they have to undergo, are of such importance that we shall shortly describe the principal mountain stations available for the treatment of phthisis, whilst a number of other places which may be used for general purposes will be named according to districts. Many of the places thus mentioned are available only during a few months in summer, and the greater part of them are suitable merely for those who do not require strict medical supervision, as medical advice cannot be had on the spot.

We commence with the European Alps.

Davos-Platz.

Davos-Platz, in the Grisons, has in the course of a few years risen to the highest rank as a mountain health resort for consumptive invalids. The valley of Davos is about half a mile wide, stretching from N.E. to S.W., the village being situated at the north-west slope of the valley. Its elevation above the sea level is 5,124 feet, the mean barometric pressure being about 24·8 inches, with a minimum in 1876 of 23·97 and a maximum of 25·33 inches. The mean annual temperature was in 1867, according to Spengler, 37° F.; in 1874, according to W. Steffen, 35·83°; and in 1876, according to the same observer, 37·74°. The differences of temperature between summer and winter are very great, ranging from a minimum of 13° F. below zero to a maximum of 75·2°, and those between day and night or, in many cases, between two succeeding days, are also considerable. The mean temperature for the winter months (November to March) has nearly always been below 32° F., January generally being the coldest month, with a temperature of about 20° or 21°, whilst July and August are, as a rule, the warmest months, with a mean of 54° or 55°. From the low averages prevailing during the winter months, and representing shade temperatures, we must not draw any conclusions as to the temperatures to which invalids are exposed. As stated in our general remarks on climates of high altitude, the sun temperature is always very high. Regarding this point we refer to the observations of Waters, Frankland, and others, adding here the means of the maxima of the sun temperatures as recorded by Francis Redford from daily observations made in Davos during the winters of 1876 and 1877, and also, for the sake of comparison, the maxima of the shade temperatures according to a table given by Steffen.

Means of the maxima in the shade—

October	November	December	January	February	March
60·4°	36·63°	39·0°	36·05°	34·75°	36·46°

Means of the maxima in the sun—

October	November	December	January	February	March
133·07°	106·12°	109·08°	108·30°	111·36°	122·32°

The sun temperatures being so high, it is easy to understand that even the subjects of advanced disease are enabled to sit in

the open air during sunshine. However, even in the shade and in the absence of sunshine, low temperatures produce very little discomfort at Davos, as compared with level countries, partly on account of the dryness of the air, partly also because there is very little wind in winter.

The mean relative humidity was, in 1876, 75·2, ranging from 80·4 at 7 A.M. to 57·6 at 1 P.M. and 87·6 at 9 P.M., and being on the average somewhat higher in winter than in summer. As, however, the degree of absolute humidity is of particular importance in regard to the effects of moisture on the lungs, we have to bear in mind that, according to Steffen, a cubic metre of air contains only 4·8 grammes of aqueous vapour. Thus air heated to 98·4° F., this being the supposed temperature of the air expired, could take up the further amount of 38·7 grammes of aqueous vapour for each cubic metre, as air at 98·4° could contain 43·5 grammes of aqueous vapour. The mean relative humidity of Davos at 98·4° would have been, in 1876, 11·1 per cent., and as to each month—

For January . .	5·3 per cent.	For July . . .	18·2 per cent.
„ February . .	6·6 „	„ August. . .	18·7 „
„ March . . .	7·5 „	„ September . .	12·9 „
„ April . . .	10·5 „	„ October . .	12·1 „
„ May . . .	11·0 „	„ November . .	7·1 „
„ June . . .	16·2 „	„ December . .	6·8 „

The amount of rain was in 1867, according to Spengler, 37·43 inches; in 1876, according to Steffen, 41·41 inches. Rain or snow fell in 1876 on 159 days, the number of clear days being 112. The mean amount of cloud is given as 4·7. Snow lies on the average from the middle of November to the middle of March, and during this period the air is much calmer than in summer, although stormy days are not entirely absent in winter.

Davos is at its best in winter, owing to the greater purity of the air, the number of clear days, and the calm atmosphere, whilst in summer there is some amount of dust, and the heat during the day is often great, so that the absence of shade in the immediate surroundings makes itself much felt, the mornings and evenings being often cold at the same time. Besides,

the mountain and valley winds prevailing in summer are frequently disagreeable. The medical treatment in Davos consists chiefly in the application of douches, which are invariably made by the physicians personally, and of the wet pack. Much attention is paid, at the same time, to diet: large quantities of warm cow's milk, at times koumiss prepared from cow's milk, and in some cases a liberal allowance of wine, are prescribed. Outdoor exercise is regulated by the physicians, and the number of level and gently rising walks has been much increased of late by the activity of the local committee. A greater number of sheltered seats is, however, to be desired.

Considering the number of patients who anually visit Davos, it is much to be desired that physicians could be induced to communicate records of all their results, whether good or bad. A laudable beginning in this direction has been made by Dr. Ruedi, who together with Dr. Clifford Allbutt published a series of cases in the 'Lancet' of 1878 and 1879; and Dr. Theodore Williams has also given his experience in the 'Lancet' of 1879.

There is a fair number of hotels, and their internal arrangements have greatly improved of late years. Invalids should in any circumstances choose south bedrooms of large size.

It is worthy of notice that boarding schools have been established at Davos for boys as well as for girls, thus giving an opportunity of placing delicate children under the influence of the climate without neglecting their education.

Davos-Dörfli.

Davos-Dörfli, a mile and a half higher up in the valley, has a similar climate. In winter it has the advantage over Davos-Platz of having the sun half an hour or more longer each day. On the other hand, Davos-Dörfli is not so well protected from winds, being situated opposite to the entrance of Dischma valley. On the whole it is not inferior to Davos-Platz, being also provided with a good hotel and having a resident physician (Dr. Volland).

Davos-Frauenkirch.

Davos-Frauenkirch, $2\frac{1}{2}$ miles below Davos-Platz, and at a slightly lower elevation, offers similar climatic conditions. Its accommodation is improving, and it has also the advantage of a resident physician.

Wiesen is situated in the same Alpine valley, about 11 miles below Davos-Platz, and 4,757 feet above the level of the

sea. It probably enjoys more sunshine, and we think that as good results might be obtained at Wiesen as at Davos. As yet, however, it has not had many winter visitors.

Wiesen.

The village of St. Moritz, in the Upper Engadine, 6,089 feet above the level of the sea, lies on a sunny slope about 300 feet above the bottom of the valley, and affords most favourable conditions. A good many years ago, with the assistance of Dr. Berry, I obtained good results in several patients whom I had sent to St. Moritz either for summer or winter residence, and these results were particularly striking in the case of the latter category. No provision being made at that time for delicate consumptive invalids by heating passages and similar means, St. Moritz did not come into favour as a winter station. Lately, however, one of the hotels belonging to Herr Badrutt (a thoroughly practical man) was fitted up with all the arrangements requisite for winter residence, and we have no doubt that good results may be obtained. In summer the whole district is so gay, and the temptation to mix with the many healthy visitors who come for change and amusement only is so great, that the strictest medical supervision by a physician devoting all his time to this particular treatment would seem necessary, and also, so far as possible, the separation of the consumptive invalids from those visitors who come merely for change or pleasure. The climate is very similar to that of Davos, though the snow begins to remain permanently on the ground somewhat earlier and begins to melt rather later. The mean annual temperature, according to extensive observations kindly made for us from 1868 to 1871 by Messrs. Townsend and Greathead, is slightly lower, whilst the sun temperatures were very much the same; the number of fine winter days is very high; winds are rare in winter; the absolute humidity is somewhat less in amount, and so also is the fall of rain or snow and the number of rainy days. The mean number of perfectly clear days in St. Moritz is 24, those clear for the greater part of the day being 160, and those with rain or snow 136. According to observations extending over some twenty years in Bevers with a slightly less favourable situation, the number of perfectly clear days is 21·5, whilst

Village of St. Moritz.

those clear for the greater part of the day number 159·9, and the days with rain or snow 137·7. The annual amount of rain in the Upper Engadine is slightly in excess of that in Davos.

Samaden. Samaden, the chief village of the Upper Engadine (5,652 feet), is situated at a lower elevation than St. Moritz above the bottom of the valley and the surface of the inn; it is also dustier and more exposed to winds, but the results hitherto obtained in patients remaining there through the winter season have been satisfactory, particularly in those who stayed at the Hôtel Bernina, which has the advantage of much sunshine. As a house has now been specially fitted up for the reception of winter visitors, it seems likely that Samaden will in time become a frequented winter health resort.[1]

Pontresina. Pontresina (5,997 ft.), situated in a lateral valley of the Engadine on the Bernina road, at a similar elevation as St. Moritz, has not yet been used as a winter health resort, but the climatic data given by Dr. Ludwig make it very probable that good results might be obtained there. From its situation it may, even on the shortest day of the year, enjoy the direct rays of the sun for six hours and forty minutes. As a summer resort it is noted quite as much as St. Moritz for the invigorating influence of its climate. For a detailed account of the whole Upper Engadine we refer to the very instructive essay by J. M. Ludwig, 'Das Oberengadin in seinem Einfluss auf Gesundheit und Leben,' Stuttgart, 1877.

There are several other spots in the Upper as well as Lower Engadine which would be suitable for summer and winter stations, owing to sunny situation, dry soil, shelter from winds, and the possibility of laying down level walks. Such sites might be found near Celerina (5,656 ft.), situated between St. Moritz and Samaden; near Campfer (6,004 ft.), between St. Moritz and Silvaplana; near Vettan (5,380 ft.), not far from Tarasp and Schuls; and especially near Lü, situated on a slope above the Münsterthal, in the Grisons, at an elevation of 6,293 feet, with a southern aspect and consequently much sunshine, advantages which become evident by the fact that corn ripens at this great height.

[1] A large hotel which is open to winter visitors has recently been started on the Maloya Pass.—*Tr.*

Amongst other places in Switzerland well adapted to consumptive invalids we mention the Maderanerthal, with the Hôtel Alpenclub (4,790 ft.); St. Beatenberg (3,767 ft.), above the Lake of Thun; and Les Avants (3,212 ft.), above the Lake of Geneva.

In the Dolomites also health resorts might be started—for instance, in the Ampezzo valley, near Cortina—and the same holds good for several other places in the Southern Tyrolese Alps, as, for instance, Campiglio, situated not far from Pinzolo.

The European Alps present a great selection of *summer* health resorts, at different elevations. In giving an account of such places we begin with the highest, excluding those already noticed:—

Summer health resorts in the European Alps.

The Hôtel Belalp, above the Rhône valley, 6,732 feet, with a sunny aspect.

The hôtel on the Engstlenalp, in Canton Unterwalden, 6,033 feet.

Silvaplana, in the Upper Engadine, 5,958 feet.

Sils Maria, in the Upper Engadine, 5,941 feet.

Santa Catarina, near Bormio, 5,700 feet.

Zuz, in the Upper Engadine, 5,548 feet.

Rigi-Scheideck, 5,407 feet.

Murren, above Lauterbrunnen, 5,348 feet.

The Baths of San Bernardino, in the Grisons, 5,335 feet.

The Hôtel des Alpes, Wengern, in Canton Bern, 5,288 feet.

The Chasseral, in the Jura, near the Lake of Bienne, 5,279 feet.

Rigi-Staffel, 5,210 feet.

Pejo, in Southern Tyrol, with chalybeate springs, 5,150 feet.

Campiglio, near Pinzolo, above the Sarca valley, 4,986 feet.

Parpan, in the Grisons, 4,937 feet.

Spinabad, 4,901 feet, and Glaris, near Davos-Platz.

The hôtel on the Voirons, near Geneva, 4,777 feet.

The Hôtel Alpenclub, in the Maderanerthal, 4,753 feet.

Rigi-Kaltbad, 4,728 feet, and, near it, Rigi-First.

The Baths of Morgins, in Wallis, 4,629 feet.

The health resorts of the Val Ampezzo, in the Dolomites—Landro, 4,615 feet, and Schlunderbach, 4,730 feet, in a sunny situation.

Obladis, in the Tyrol, 4,530 feet.

Fladnitz, near the railway station of Friesach, in the Austrian Alps, 4,462 feet.

Comballaz, in Canton Vaud, 4,475 feet.

The New Baths of Bormio, 4,396 feet.

Rosenlaui, in the Bernese Oberland, 4,363 feet.

The Hôtel Stoss, on the Fronalpstock, 4,242 feet.

Villars (sur Ollon), in Canton Vaud, 4,183 feet.

Schröcken, 4,150 feet, a small Alpine village surrounded by forests and beautifully situated in the Bregenzer Wald. This district and the adjoining Algäu offer several good stations; for instance, Mittelberg (3,969 feet), situated in the Walserthal, and a good many other places might be named, both in the Austrian and Bavarian Alps, which, though not much frequented, would very well answer the requirements of health resorts.

The Baths of Rabbi, in Southern Tyrol, 4,100 feet, with fine surroundings and a mild chalybeate spring.

Tarasp-Schuls, in the Lower Engadine, 4,087 feet.

Courmayeur, in Piedmont, above Aosta, 3,986 feet.

Churwalden, in the Grisons, 3,976 feet.

Cortina, in the Val Ampezzo, 3,969 feet, possesses in its surroundings sunny and sheltered spots, which would be well adapted for the erection of a sanatorium for consumptive invalids. The village offers good accommodation, and is much frequented in summer, owing to its central position in the Dolomites. This mountain district includes many other less known Alpine places of moderate elevation, San Martino de Castrozzo and Vigo being among the higher of these, and Caprile and Primiero among the lower.

Gsteig, in Canton Bern, 3,937 feet.

Ormond-Dessus, in Canton Vaud, 3,815 feet.

Gurnigel, in Canton Bern, with extensive pine woods in the environs, 3,782 feet.

Dissentis, in the Grisons, 3,773 feet.

St. Beatenberg, above the Lake of Thun, 3,762 feet.

The Abendberg, near Interlaken, 3,736 feet.

Gryon, above Bex, in Canton Vaud, 3,723 feet.

Bad Fusch, in the Tyrol, 3,750 feet.

Le Sepey or Ormond-Dessous, in Canton Vaud, 3,707 feet.

Flims, in the Grisons, 3,706 feet.

Chaumont, in the Jura, above Neuchâtel, 3,700 feet.

St. Leonhard, in Carinthia, 3,635 feet.

The Baths of Lenk, in Canton Bern, 3,624 feet.

Fideris, in the Prättigau, 3,464 feet, with good chalybeate springs.

Chamonix, in Savoy, 3,451 feet.

St. Cerques, in the Jura, 3,432 feet.

Grindelwald, in the Bernese Oberland, 3,431 feet.

Champéry, in the Val d'Illiex, 3,389 feet.

Saanen, in Canton Bern, 3,362 feet.

Engelberg, in Canton Unterwalden, 3,342 feet.

We next come to the enumeration of stations situated in the Alps, ranging between 700 and 1,000 metres in elevation (about 2,300 and 3,300 feet respectively). These no longer possess a truly Alpine character, but rather belong to the mountain group of moderate elevation. Amongst them are many places suitable for summer residences, both for consumptives and for others who require pure air and a moderate amount of sun. Generally speaking, they are less bracing, have a higher mean temperature, a greater barometric pressure, and more moisture; on the other hand, the differences between the temperatures in the day and at night, and in the sun and in the shade respectively, are less, and the air contains more organic impurities. In selecting residences, it is therefore of importance to see that they are built on dry and, if possible, rocky ground, on declivities with a good fall of surface water, and not in the depth of valleys, nor near factories and stables, or accumulations of manure. The presence of forests in the neighbourhood is indispensable to afford shade during the greater heat prevailing in summer; and, if the places are used in winter, a southern or south-western aspect is of great importance, whilst for summer residence an eastern or northern aspect, where the heat is less felt, is in many cases preferable.

These conditions are met with more or less at the following stations:—

Château d'Oex, in Canton Vaud, 3,261 feet.

Sarnthein, near Botzen, in Southern Tyrol, 3,248 feet.

Les Avants, above Montreux, in a sunny situation, 3,215 feet.

Le Prese, in the Grisons, situated near the lake of the same name on the Bernina road leading into the Veltlin, 3,146 feet.

Alveneu, in the Albulathal, 3,116 feet.

Seewis, in the Grisons, 3,116 feet.

Gais, in Canton Appenzell, the old and famous place for whey cures, 3,064 feet.

Achensee, in the Tyrol, 3,051 feet.

Felsenegg, in Canton Zug, 3,041 feet.

Trogen, in Canton Appenzell, 2,969 feet.

The Baths of Weissenburg, in Canton Bern, 2,940 feet.

Gonten, in Canton Appenzell, 2,900 feet.

Bürgenstock, above the Lake of Lucerne, 2,854 feet.

Uetliberg, near Zürich, 2,844 feet.

Trons, in the Grisons, 2,822 feet.

Mariazell, near Bruck, in the Tyrol, 2,791 feet.

Reutte, in the Tyrol, 2,755 feet.

Teufen, in Canton Appenzell, 2,742 feet.

Bad Kreuth, in Bavaria, about 2,700 feet.

The Weissbad, in Canton Appenzell, 2,690 feet.

St. Gervais, in Savoy, 2,674 feet.

Oberstdorf, near Sonthofen, in the Allgäu, 2,660 feet.

Heiden, in Canton Appenzell, 2,644 feet.

Seelisberg, above the Lake of Lucerne, 2,628 feet.

Schliersee, in Bavaria, 2,588 feet; and above it Bayrischzell, 2,818 feet.

Chavannes, in Canton Bern, 2,559 feet.

Waidring, 2,558 feet, not yet much known, in a good situation between Wörgl and Reichenhall.

Appenzell, 2,552 feet.

Herisau, in Canton Appenzell, 2,549 feet.

Heinrichsbad, in Canton Appenzell, 2,546 feet.

Faulensee-Bad, above the Lake of Thun, 2,493 feet.

Zell am See, in the Tyrol, 2,475 feet.

Axenstein, above the Lake of Lucerne, 2,460 feet.

Sonnenberg, near Lucerne, 2,460 feet.

Thusis, in the Grisons, 2,447 feet.

Sonthofen, in the Bavarian Alps, 2,420 feet.

Kitzbichel, in the Tyrol, 2,418 feet.

St. Radegund, in Styria, 2,411 feet.

Tegernsee, in Bavaria, 2,400 feet, situated on the lake of the same name, with various good places in the environs.

Partenkirchen and the Kainzenbad, in the Bavarian Alps, about 2,370 feet.

Ilanz, in the Grisons, 2,351 feet.

Monnetier, on the Salève, in Savoy, 2,336 feet.

Schöneck, in Canton Unterwalden, 2,313 feet.

Of stations in the Alps with an elevation below 2,300 feet (700 metres) there are but few suitable for summer residence in the majority of cases, the heat being often very great. The climatic conditions, however, will be modified to some extent according as to whether the place has a northern or eastern aspect, or is situated in the northern part of the Alps, or, conversely, has a south or south-western aspect. Several of the places situated in Alpine valleys and on Alpine lakes will be enumerated later on under 'Low Inland Climates.'

Schönbrunn, Canton Zug, 2,290 feet.

Miesbach, in Bavaria, 2,286 feet.

Glyon (Hôtel Righi Vaudois), above Montreux, 2,254 feet.

Obstalden, above the Lake of Wallenstadt, 2,231 feet.

Mürzzuschlag, at the foot of the Semmering, 2,195 feet.

Giessbach, above the Lake of Brienz, 2,165 feet.

Bad Stachelberg, in Canton Glarus, 2,162 feet.

Axenfels, below Axenstein, 2,145 feet.

Aussee, in Styria, 2,132 feet.

Albisbrunn, in Canton Zürich, 2,116 feet.

Admont, in Styria, 2,100 feet.

Kochelsee, in the Bavarian Alps, 1,985 feet.

Charnex, near Montreux, 1,902 feet.

Lebenberg, near Meran, 1,867 feet.

German mountain climates.

In the mountain ranges of *Germany* we meet with but few places situated above 2,500 or 3,000 feet; but, in these, the higher latitude and the lower elevation of the surrounding mountains give them a decidedly subalpine character as to temperature, moisture, and particularly vegetation. Two resorts (Görbersdorf and Falkenstein), having, from their establishments for the treatment of consumptive invalids, attained especial notoriety, will be placed foremost in

our list, although they have lower elevations than some of the places to be mentioned hereafter.

Görbersdorf. Görbersdorf is a long, straggling village situated in one of the mountain valleys of the Sudetes, in Silesia, about 1,800 feet above the sea, and sheltered from the more violent winds by mountain ranges which are mostly covered with pine forests. The mean temperature for the summer season (from May to September) is, according to Brehmer, about 57·5° F.; the number of the almost entirely fair days during these months being about 100, that of cloudy days 40, and that of the quite overcast and rainy days about 15. The valley is partly covered with snow in winter, and its elevation, as well as mean temperature, being lower than that of Davos, it stands to reason that the snow melts at times, thus causing dampness of the soil. This, however, does not interfere so much with outdoor exercise in Görbersdorf as at many similar places of moderate elevations, owing to the sloping situation and porous soils of the grounds attached to Dr. Brehmer's establishment. The air is free from artificial impurities. When the establishment was first founded (1859) patients were admitted during the summer months only, but for a considerable period it has been kept open the whole year through. The patients are under the strict supervision of Dr. H. Brehmer himself, and his two assistant physicians. The principles of treatment are chiefly these: meals at short intervals, wine being allowed; the spending much time in the open air, hammocks being provided for delicate patients in the adjoining pine woods; regular exercise is insisted upon and cold water treatment is used, mostly in the form of douches (as a jet or shower), which are applied by one of the physicians personally, a skilled attendant doing the rubbing. Though detailed reports of results are wanting, it would appear, from such communications and observations as are accessible, that in the case of phthisical patients they are more satisfactory than formerly. This is also shown to some extent by the fact that a rival establishment on the same model has been founded in Görbersdorf by Herr von Rössing, which is likewise under medical supervision (Dr. Römpler) and is conducted according to the same principles. If we draw a parallel between Görbersdorf and Davos, we find that in summer

the former has the following advantages, which are not possessed to an equal degree by the latter: the immediate neighbourhood of pine forests, affording agreeable shade; a rather equable climate; comparative rarity of trying winds; and also the fine walks which in the adjoining Waldberg rise gently to a height of 1,000 feet above the establishment, and, being well provided with seats, form an excellent curative agent, adapted to consumptive patients of all degrees of strength. For winter, on the other hand, the more elevated Alpine climate, with its characteristics as described above, must be preferred in most cases suitable for treatment by high altitudes.

Falkenstein.

The Curanstalt Falkenstein, situated on the slope of the Taunus, near the railway stations of Soden and Kronberg, at an elevation of 1,410 feet above sea level, is an establishment of the same kind as Görbersdorf. During its comparatively short existence, and under the skilful direction of Dr. Dettweiler, who formerly assisted Dr. Brehmer, it has been considerably improved upon, and has already attained great reputation as an establishment for the treatment of consumptive patients. The mountains do not completely protect from the east winds, but means have been taken to obviate this disadvantage as far as possible. Many sheltered walks have been laid out in the neighbourhood, and facilities are offered for even the more confirmed invalids to be out in the open air. In winter Falkenstein cannot be compared with Davos and similar places of high altitude. Its advantages for consumptive patients consist, to a considerable extent, in the strict supervision to which they are subjected.

After this short account of the resorts specially adapted for the treatment of pulmonary affections at present available—probably others of a similar kind, and with even more complete arrangements, will before long come into existence—we shall enumerate, according to their heights, a series of elevated summer health resorts in Germany which might be made suitable by proper arrangements for a longer period than the two or three summer months. A detailed account of the places of this class will be found in Reimer's 'Klimatische Sommerkurorte,' 1877.

Höchenschwand (3,313 feet), in the southern portion of the

Black Forest, may be considered as the highest health resort in Germany, apart from the Alps. It has a bracing air, but it is exposed on all sides to winds, and the woods affording shade and shelter are at too great a distance for delicate persons.

Waldau (3,149 feet), also in the South of the Black Forest, near the Donaueschingen station, is better protected, owing to its situation in a hollow, but it is less bracing.

Schluchsee (3,118 feet), about 12 miles distant from the nearest railway stations (Freiburg i. Br. and Waldshut), is in a most beautiful position, but offers only moderate accommodation.

St. Märgen (2,920 feet), about 9 miles distant from Freiburg i. Br., with tolerable accommodation, has a moderately bracing air, shady walks in its neighbourhood, and is well situated for longer excursions.

Bonndorf (2,788 feet), in the south-eastern portion of the Black Forest, several miles distant from the stations of Waldshut and Donaueschingen, is moderately protected from winds and offers moderate accommodation.

Todtmoos (2,690 feet), in the south of the Black Forest, surrounded by mountains, offers attractive walks in the adjoining pine forests.

Hohwald, in the Vosges Mountains, has fine forests, and may be recommended from early summer to autumn. The Vosges afford several other good places available as summer health resorts—for instance, Odilienberg, near Strassburg, and the Drei Aehren, in the Münsterthal, both being in elevation slightly below Hohwald.

Karlsbrunn (2,493 feet), in the Austrian portion of the Sudetes, has a most bracing air. It also possesses chalybeate springs and an hydropathic establishment.

St. Blasien (2,428 feet), situated in the picturesque Albthal of the Black Forest, offers many opportunities for excursions and good accommodation.

Steinamühle (2,428 feet), near Bonndorf (noticed above), in the Black Forest, possesses good arrangements for river baths and fine forests.

Wildenthal (2,395 feet), in the Erzgebirg, is surrounded by beautiful forests.

Königswart (2,296 feet), in the Erzgebirg, not far from

Marienbad, in Bohemia, possesses good chalybeate springs and an excellent climate.

Reiboldsgrün (2,263 feet), in the Erzgebirg, with chalybeate springs, situated in the midst of a forest, and possessing a pronounced forest climate, has lately been frequented by consumptive patients, who are treated according to the Görbersdorf method.

Heiligenberg, with a similar elevation, between the station of Pfallendorf and the north-western end of the Lake of Constance, has a fine situation and enjoys particularly pure air.

Frauenstein (2,165 feet), in the Erzgebirg.

Johannesbad (2,066 feet), with an indifferent thermal spring, is situated in a beautiful and woody valley near Trautenau, in Bohemia.

Gräfenberg (2,066 feet), the well-known hydropathic establishment in Silesia, is also available for climatic treatment.

Hohegeiss (2,034 feet), a village with limited accommodation, is situated in a valley of the Harz Mountains and is surrounded by wooded hills.

Triberg (2,034 feet), in the Black Forest, on the new Black Forest line, near the well-known waterfalls, has ample accommodation.

Schreiberhau (2,018 feet), near Warmbrunn, in Silesia.

Muggendorf (1,968 feet), and *Streitberg* (1,920 feet), in Bavaria, have for years attracted many visitors, owing to fine scenery, invigorating air, and the opportunities they afford for the milk and whey cure under good medical supervision.

Brotterode (1,935 feet), in the Thuringian Forest, has a keen air but healthy climate.

Rippoldsau (1,870 feet), the most elevated of the Kniebis baths in the Black Forest, offers very good accommodation, with facilities for beautiful forest walks, and is also noted for its earthy saline springs.

Clausthal (1,837 feet), in the Harz Mountains, is very invigorating, but the air is rather keen.

Alexandersbad (1,837 feet), in the Fichtelgebirg, possesses a well-arranged hydropathic establishment, chalybeate springs, and fine scenery, with an invigorating climate.

Reinerz (1,820 feet), in Silesia, famous for its chalybeate

springs, may also be recommended for its climate and for the use of milk or whey.

Flinsberg (1,640 feet), in Silesia, also possesses chalybeate springs and a woodland climate.

Schwarzbach (1,640 feet), situated near Flinsberg, is quite surrounded by pine forests.

Griesbach (1,623 feet), in the Black Forest, near Rippoldsau, is noted for its chalybeate springs and its climate.

Antogast (1,590 feet) is situated close by Griesbach.

Lobenstein (1,574 feet), in the principality of Reuss-Lobenstein, possesses chalybeate springs and other curative resources.

Ilmenau (1,558 feet), in the Thuringian Forest, is a favourite health resort and has a hydropathic establishment.

Elgersburg (1,542 feet) is a hydropathic establishment situated in Thuringia and, like the former, much in vogue on account of its invigorating climate and beautiful forest walks.

Olbernhau, *Wolkenstein*, *Warmbad*, *Einsiedel*, and *Wiesenbad*, all situated in the Erzgebirg, may be described as belonging to the bracing woodland climates; they range in elevation from 1,400 to 1,500 feet.

In the central districts of the Black Forest there are many places situated between 1,300 and 1,450 feet which may be recommended on account of pure forest and mountain air, and the good opportunities they afford for outdoor exercise. Such places are *Schönmüntzbach*, *Petersthal*, *Teinach*, *Feiersbach*, *Herrenalb*, and *Liebenzell*.

A prominent place must be given to *Badenweiler* (1,337 feet), which has been for years a favourite resort, owing to its good situation on the western slope of the southern portion of the Black Forest and its charming neighbourhood. It is well situated for a more protracted residence, having the advantages of tepid springs and a superior swimming bath, milk and whey establishments, and first-rate medical advice. The season extends from early summer to the end of autumn.

At a similar elevation, and also somewhat lower, there are several excellent summer health resorts in the Thuringian Forest, such as Friedrichsroda (1,345 feet), which, from its situation at the north-eastern slope of the mountain range, is cooler and drier than many more southern places of greater

elevation, and has at the same time a more equable temperature and much shelter, owing to the surrounding forests. *Ruhla*, at a similar elevation, *Tabarz*, *Tambach*, *Georgenthal*, *Ohrdruff*, *Louisenthal*, *Schleusingen*, *Sonneberg*, and *Blankenhain* are situated at a somewhat lower elevation above the sea level, and offer a variety of accommodation to suit different requirements. *Liebenstein* (1,033 feet), with cold water establishments, chalybeate springs, and good medical advice, though about 300 feet below Friedrichsroda in elevation, has a bracing climate, owing to its beautiful beech woods. *Arnstadt* (1,017 feet) has, in addition to its brine baths, a healthy and well-sheltered situation.

In the east of Germany the Riesengebirge and the Sudetes offer a good many summer resorts situated at elevations from 1,000 to 1,500 feet, of which the best known are *Schmiedeberg*, *Buchwald*, *Roznau*, *Liebwerda*, *Petersdorf*, *Erdmannsdorf*, *Hermsdorf*, *Warmbrunn*, and *Fischbach*, whilst in the Erzgebirg we have, at similar elevations, *Eichwald* and *Hartenstein*.

The Harz Mountains, in the North of Germany, possess several excellent places belonging to this class, which are mostly situated at elevations ranging from 700 to 1,300 feet, but, owing to the isolated projection of the Harz Mountains from the North German plain, have climatic characteristics similar to places lying more to the south and having twice the elevation. The following resorts are much frequented: *Grund*, *Alexisbad*, *Klostermühle*, *Blankenburg*, *Stolberg*, *Sachsa*, *Thale*, *Wernigerode*, *Ilsenburg*, and *Harzburg*. There are other places which have a higher situation, and are therefore more bracing, though the accommodation is not so good—*Hohegeiss* (2,198 feet), *Clausthal* (1,837 feet), *Andreasberg* (1,837 feet), and *Altenau* (1,509 feet). Hotels which are much frequented by tourists, such as those on the Rosstrappe and the Brocken, may have the advantage of affording a more invigorating climate, but are just as little adapted to invalids requiring rest as the well-known hotels on the Rigi or Pilatus.

In Mid-Germany there are many climates, at elevations of from 700 to 1,400 feet, a change to which benefits townspeople and the inhabitants of plains; thus we have *Königstein* and its environs in the Taunus, *Wilhelmshöhe* and *Wolfsangers* in

the Habichtswald, and several places in the Westerwald, which are as yet scarcely available for want of accommodation, and also places on the Hunsrück and in the Eifel, where good quarters may be found at the Laacher See (920 feet). The Franconian Mountains, in Bavaria, offer, in addition to Muggendorf and Streitberg, mentioned above, several other places of less elevation, such as *Phantasie* and *Berneck*. The Odenwald and the Haardt also offer summer health resorts, but these cannot be grouped under the mountain climates unless with few exceptions, such as *Gleisweiler* (944 feet), which possesses an hydropathic establishment, good milk and whey, and fine forests in its neighbourhood.

After thus passing in review the mountain health resorts of Germany, we turn once more to the Alps and the Jura range.

Lowest Alpine climates.

These, at an elevation between 1,000 and 2,000 feet, contain many places which can neither be classed under the Alpine nor the sub-Alpine climates, but offer a kind of lowest Alpine climate (*Voralpenklima*). Places belonging to this group, even if they lie at the same elevation above the sea, offer very different climatic conditions, according as they are situated either on the northern or southern side of the main chains, on slopes or in broader or narrower valleys; according also to the protection afforded to them by mountains, the direction of the prevailing winds, and the direction of the valleys. Thus we have stations suitable for residence in spring, autumn, or winter, and also intermediary stations. The feature common to all of them is that their climatic conditions are modified by the proximity of high mountain ranges which influence the prevailing winds, the temperature, and moisture. Hence we do not include them in the climates of level countries. Some of them, moreover, are influenced, in the manner explained above, by great inland lakes on which they border. Generally speaking, we may say that the places situated on the northern slopes of the Alps are available as summer health resorts, whilst those situated in the interior of the Alps, and on their southern slopes, are more suitable in spring or autumn, or may, in some cases, even be used in winter if they are well sheltered and much exposed to the sun. Sudden and great changes of temperature are frequent when the wind changes. Hence invalids must be very cautious, and advanced cases should be sent to such stations

only exceptionally, or when an intermediary station is wanted by patients removing from a more extreme climate to a milder one.

The *Starnberg Lake* or *Wurmsee* (1,935 feet), situated on the northern slope of the Bavarian Alps, offers at its borders several places which are bracing in summer and early autumn, such as Starnberg, Feldafing, Tutzing, and Allmannshausen. Near the lake and at a somewhat lower elevation is the Ammersee, with Greifenberg and the neighbouring Pähl. Tegernsee, situated on the lake of the same name, exercises a soothing and invigorating influence and may be recommended from early summer to mid-autumn.

Thun, on the Lake of Thun (1,853 feet).

Interlaken (1,863 feet) lies in the old lake basin which was formerly covered by the two lakes (of Thun and of Brienz), evidently forming a single sheet of water. Interlaken is somewhat more under the influence of the two lakes than Thun, is slightly moister and has a more equable temperature. Though to a certain extent protected from winds (S. and N.), it is notwithstanding exposed to considerable and sudden changes. With certain precautions, however, the climate is available in the early and latter part of summer up to mid-autumn, whilst at the height of summer it is too hot for most people.

The *Chiemsee* (1,673 feet), in the south of Bavaria, contains several islands which may be visited by people in quest of rest and recreation from early summer to mid-autumn.

Mondsee, on the lake of the same name, in the Tyrol, (1,640 feet).

Mornex, on the Salève (1,640 feet).

Ischl (1,574 feet) owes the peculiarly soothing influence of its climate, comparative freedom from winds, and its luxuriant vegetation to the manner in which the place is surrounded by high mountains. In summer and the early part of autumn all the advantages which food, milk, whey, baths, and medical advice can offer are to be met with there.

Kammer (1,560 feet), on the Attersee.

Reichenhall (1,509 feet), in the Bavarian sub-Alpine districts, situated in a long valley moderately protected by the surrounding mountains, offers good climatic conditions, facilities for the use of milk or whey, noted salt springs, an establishment for

air baths (well known in the profession by Liebig's publications), and excellent medical advice. In the same district lie *Berchtesgaden*, *Ramsau*, *Hintersee*, and *Königsee*.

We may, further, name here—

Chouilly, *Peissy*, *Bessinge*, *Jussy*, *Chougny*, *Bourdigny*, *Cologny*, *Prégny*, *Saxoney-le-Grand*, and *Saxoney-le-Petit*, in the cantons of Geneva and Vaud (between 1,500 and 1,650 feet).

St. Aubin, *Boudry*, *Colombier*, *Auvernier*, and *Neuchâtel* (between 1,450 and 1,600 feet), in Canton Neuchâtel.

The *Lake of Lucerne* offers a series of health resorts situated close to its banks, at an elevation of about 1,450 feet; places near it, but having a higher elevation, have been referred to above. *Gersau*, *Wäggis*, *Vitznau*, having a southern aspect, are suitable for residence in spring and autumn, whilst in summer they are too hot for many persons; *Meggen* and *Hertenstein*, situated on the Küssnacht arm of the lake, also belong to this group, whilst the places having a northern aspect, such as *Beckenried* and *Buochs*, are more suited for the summer season, although most persons staying there for some time find them too hot and not sufficiently bracing.

Weesen and *Wallenstadt* (1,377 feet), near the Lake of Wallenstadt.

Gmunden (1,377 feet), situated at the efflux of the Traun from the Traunsee, possesses salt baths and accommodation for bathing in the river or lake, and there are shady walks in the environs.

Aigle (1,375 feet), above the lower Rhone valley, has several good hotels, and may in some cases be recommended as a spring or autumn station.

Bex, (1,345 feet), situated above the Rhone valley, possesses salt springs, and its climate has the advantage over many similar ones of being particularly suitable for the spring season, when a difficulty is always experienced in finding out a suitable place. It has a resident physician and the accommodation is good. Bex may, therefore, be recommended as an intermediary station, especially for spring.

On the Lake of Constance (1,306 feet) there are a number of places which offer a moderately bracing climate, together with opportunities for baths in the lake. Amongst them *Ueberlingen*,

Friedrichshafen, and *Lindau* have a southern aspect; *Bregenz* (possessing in the Pfänder—3,464 feet—a convenient mountain station) lies at the east, *Constance* at the west end of the lake; *Rudolfzell* lies near Constance, and *Mammern* and *Rorschach* on the Swiss bank.

Divonne (1,540 feet), near Nyon, situated on the slope of the Jura, at a distance of about four miles from the Lake of Geneva, possesses a mild climate, particularly suitable for spring and autumn, and offers opportunities for hydropathic treatment in Dr. Vidard's well-known establishment.

Beaurivage, near Lausanne, is also well adapted for residence in spring and autumn.

Vevey (1,246 feet), the noted health resort on the Lake of Geneva, has the advantage of an equable climate, owing to its situation on the lake, and is moderately protected from cold winds by mountain ranges which lie to the north and north-east of the town, though they are scarcely near enough to afford complete shelter. The well-arranged hotels add to the facilities for using the place as a spring and autumn station.

Montreux, with the adjacent hamlets of *Clarens*, *Vernet*, *Territet*, and *Veytaux*, scattered over different elevations, lies nearer to the mountain walls, thereby enjoying better protection and an additional source of warmth, owing to the reflection of the sun's rays. On the other hand, it is at times exposed to cold winds, and is rather deficient in promenades with sheltered resting-places. Montreux is adapted to many cases as an intermediary station, and may also be used in winter by patients with stationary phthisis. Montreux and Vevey are, moreover, well-known resorts for the grape cure, producing as they do grapes of superior quality, and they have the advantage of being near to more elevated and colder places, such as Glion and Les Avants, which may be reached by a short drive when hot weather comes on. Montreux and Vevey have a large annual rainfall (averaging from 50·59 to 52·75 inches), but their climates cannot be called moist. The mean annual temperature of Montreux is 50·9° F., being for the winter 36·5°, for spring 50·8°, summer 65·7°, and autumn 51·2°. The average temperature of Montreux exceeds that of Vevey by about 1·8° in winter and spring.

We include in this class of climates also the old-established autumn and winter resorts—*Meran* and *Obermais*, *Botzen* and *Gries*.

Meran, in the Austrian South Tyrol (we refer not to the old town, but to the visitors' quarters, which comprise also Obermais and Untermais), may be said really to lie on a southern slope of the Alps, at an elevation ranging between 920 and 1,180 feet and surrounded on the N., N.E., and N.W. by mountains 10,000 feet high. The boarding-houses and villas are scattered between gardens and pleasure grounds, and would enjoy almost complete shelter from the N., N.E., and N.W., did not the narrow valley of the Passer give passage to cold currents of air, to which several parts of Meran, according to their situation, are more or less exposed. The valley in which the Adige flows from the N.W. also admits cold winds, which are rather common. The air may, on the whole, be called dry; the soil dries quickly (partly gneiss and granite, partly schist and limestone), and thus gives rise to dust near the principal roads. The average rainfall is rather high in amount from September to December (11·77 inches), whilst it is low from January to April (4·33 inches). The mean temperature during the autumn and winter months shows great differences, being for September 62·6°, for October 55°, November 42°, December 35·4°, January 32·6°, February 38·1°, March 46°, and for April 54·7°. The sun temperature at sheltered places, such as the Wassermauer and the Winteranlage, both being provided with seats, exceeds the mean shade temperature by some 20 to 35 degrees, and Meran may, on the whole, be called a sunny place, enabling invalids from November to March to sit in the open air on about 70 days. The barometric pressure varies from 28·81 to 29·52 inches. The sanitary condition of the place is, on the whole, good, the mortality being only 12 to 13 in 1,000. We refer for details to the monographs by Pircher, Matzegger, Tappeiner, Knauthe, and other physicians, including also Sigmund's 'Klimatische Kurorte.' The grape cure may be carried out in autumn, the whey cure in spring, and there is an hydropathic establishment open all the year round (Dr. Matzegger).

Botzen (850 feet) has a higher mean temperature than Meren, but is not available as a resort for invalids, being too

far distant from the sheltering mountains, and therefore exposed to winds. *Gries*, on the other hand, lies at the base of the porphyry wall of the Guntschnaberg, which affords excellent shelter from the N. and N.E. Although the average temperature at about noon exceeds that of Meran by about 3·5°, Gries affords much less space for exercise, and does not possess so many lodging-houses suitable for invalids. The Sanatorium 'Austria,' however, is very well spoken of, and is superintended by a physician.

In the outskirts of the Alps we meet with many places suitable for longer or shorter residence, but as yet little known. As an instance we mention Recoaro, situated to the south of the Tyrolese Alps, about 1,320 feet high, which possesses chalybeate springs, offers satisfactory accommodation, and has picturesque surroundings.

The lakes of northern Italy.

The places bordering on the lakes of Northern Italy might be classed under different headings, but they are so much influenced by the proximity of the Alps that we consider them in this group. Only a few of the places have the shelter afforded by neighbouring mountains which would make them available as winter resorts, whilst during the summer season they are too hot for most cases. Among these are: *Cadenabbia*, on the Lake of Como; *Pallanza*, on the Lago Maggiore; Lugano, on the Lake of Lugano; and (with more limited accommodation) Gargnano and Salo, on the Lake of Garda, adjoining to which is also Riva, in the Sarca valley. Speaking within wide limits, these places are available as intermediary stations during September, October, and the beginning of November, and again during April and May; whilst in the winter months they are unsuited to delicate constitutions requiring warmth and shelter, although the climate is then sufficiently mild for persons with stationary phthisis, or convalescents from the same disease, and also for those whose object is only to find change and a sunny climate.

The mean temperatures are about 3·5° higher than in Meran and the distribution is more equable; the mean relative humidity averages between 72 and 78 in the autumn and winter months, whilst in spring it is slightly below 70. Fogs are rare. Autumn (September to November) has the greatest

average number of rainy days (from 36 to 40), winter (December to February) having the lowest (from 15 to 20), and spring (March to May) 34 to 36 days. Snow falls on an average on 6 or 8 days, but rarely lies more than a few days. Of local winds, as occurring on all the large lakes, the N. and N.E. are the prevailing ones; high winds are, however, rare, and there are not many days on which, owing to them, invalids are confined to the house. Dust is, on the whole, less annoying than on the Riviera.

As regards elevation above the sea, the Lake of Lugano has the highest situation (about 900 feet), whilst the Lake of Como has an elevation of 700 feet, the Lago Maggiore of about 650 feet, and the Lake of Garda of only 226 feet.

Of recent publications we may mention the 'Contributions' by Dr. Thomas (1873), giving an accurate account of Cadenabbia and Lugano, and also the excellent work on Pallanza by Dr. Scharrenbroich, which affords an insight into the climatic conditions not only of Pallanza, but of the whole district of the North-Italian lakes. In Cadenabbia, Lugano, and Pallanza, the principal hotels receive visitors during the whole of the year, while the Grand Hotel in Pallanza offers most perfect arrangements for autumn, winter, and spring.

Arco, situated in the Sarca valley, about four miles to the north of Riva, being only 44 feet above the Lake of Garda, and 454 feet above the Adriatic, has, according to Dr. Bukeisen, a slightly higher temperature than the just-mentioned places on the North-Italian lakes, and its air is described as particularly calm in winter. The place is exposed to the sun for a good many hours each day, and the way in which olive trees flourish shows that very low temperatures (below 16°) do not occur. There are many attractive walks, but complete shelter is not met with except at a few spots. The whole place is as yet in its infancy as a health resort, but rooms with a sunny aspect, though fitted up for moderate requirements only, can easily be obtained. *Riva* itself is too windy in winter, but answers better for spring and autumn.

For spring and autumn, and, if heat is well borne, also for summer, the Italian lakes offer many places. Thus we have at the Lago Maggiore: Stresa, Baveno, Locarno, with large hotels,

and Belgirate, Laveno, and Canobbio for persons with more moderate requirements. Orta, on the small Lake of Orta, is a good station, so also is Varese, near the lake of the same name. Bellagio, with the Villa Serbelloni, on the Lake of Como, is very agreeable for spring and autumn, but for most people too hot in summer.

After this account of the elevated and mountain health resorts of the Alps, including their extensions to the north into the German mountain ranges, and their slopes bordering on the Italian plains, it would seem as if we ought next to consider the continuation into the Maritime Alps, the Apennines, and the Abruzzi. But although these mountain ranges, no doubt, contain many well-situated Alpine or Subalpine places, the accommodation as yet is, with few exceptions, so limited that for the majority of patients these places are not available for the greater part of the year.

The Apennines and the Maritime Alps.

We may, however, name a fair number of places suitable for summer stations, such as Abetone and Serrabassa, near Pracchia, between Florence and Bologna; St. Martin Lantosque (3,120 feet), in the Maritime Alps, where a summer resort for the patients wintering on the Riviera has been founded; and, not far from the latter, Berthemont, Belvédère, Bollène, and La Cascade; Vinadio, Valdieri, Certosa di Pesio, and St. Dalmas di Tenda.

Nor does France contain any purely Alpine health resorts open the whole year round. For the summer season, on the other hand, several places are being made available; for instance, the places just noticed and situated in the Maritime Alps, which are frequented by consumptive and other patients merely for the sake of their climates. Other resorts owe their present renown to the existence of springs, mostly containing sulphur or arsenic, though their undoubted utility must to some extent be attributed to the climatic conditions, assisted indeed, in many cases, by a course of the waters.

Health resorts might, as we think, be established in the French Alps; for instance, near the Grande Chartreuse (Isère), at about 4,600 feet, or in the district of Briançon (Hautes Alpes) at elevations ranging from 4,000 to 5,000 feet. As regards climates suitable for summer, the valleys of Dauphiné offer

many pleasant and bracing places, such as the baths of *Uriage* and those of *Allévard*. Their number might easily be increased by providing sufficient accommodation, for the local conditions are very favourable. The mountains and valleys of the *Auvergne* are from year to year more frequented in summer, but they are almost devoid of patients from mid-September till the end of May. Still, the climates of *Mont Dore*, at about 3,300 feet, of *La Bourboule*, at 2,755 feet, *St. Nectaire*, at 2,570 feet, with their surroundings, and other localities as well, might be made available for the greater part of the year. The same remark applies to the Pyrenees, where at *Barèges*, *Cauterets*, *Bagnères de Luchon*, *Bagnères de Bigorre*, *Eaux Bonnes*, and other places the season is hardly long enough for enabling invalids to derive sufficient benefit from their climates, although actual winter stations could scarcely be founded here, owing to their northern aspect, and because snow does not, as a rule, remain on the ground for any length of time, but thaws frequently. At greater elevations, however, these drawbacks would disappear.

The Spanish or southern slope of the Pyrenees would probably be better adapted for winter residence, and *Penticosa*, situated on it at an elevation of 5,250 feet, enjoys a great reputation for its curative effects in consumption, though these are chiefly ascribed to the hot springs. Arrangements for the winter are, however, not made anywhere. Amongst summer resorts there are a good many others in the Pyrenees besides those mentioned above, all affording good accommodation, such as *Eaux Chaudes*, *Argelèz*, *Pierrefitte*, *St. Sauveur*, and *Luz*, in the western portion ; and in the eastern Pyrenees *Vernet-les-Bains* and *Amélie-les-Bains*, well adapted for autumn residence, also *St. Laurent de Cerdans* and *La Preste-les-Bains*.

The western declivities of the Vosges mountains also contain very good summer stations, such as *Remiremont*, *Plombières*, and *Gérardmer*.

The Ardennes, rich in pine forests, afford good summer health resorts, which may be found either in the north-east of France or in Belgium.

The mountain ranges of *England* and *Scotland*, being to some extent under the influence of the sea, differ somewhat in character from corresponding heights on continents. We meet

with a greater amount of moisture of the soil as well as of the air, an excess in the average rainfall, and a tendency to fogs, particularly in the higher mountains of Scotland and Wales. Another characteristic is furnished by the fact that the mountain districts are mostly owned by great landed proprietors who dislike to have hotels or sanatoria on their properties for fear of interference with the shooting, and rarely give the necessary permission for their erection. There are, however, some places with good accommodation, offering the advantages of particularly nourishing food and excellent hygienic conditions. In Scotland, *Braemar* and *Ballater* (between 650 and 1,000 feet), near Balmoral, have bracing climates ; *Pitlochrie*, *Blair Athole*, *Inversnaid*, on Loch Lomond, the *Trosachs*, on Loch Katrine, and *Banavie*, on the Caledonian Canal, *Crieff* and several other places offer also good summer resorts, with facilities for excursions ; and *Bridge of Allan* is one of the most sheltered and sunniest places in the interior of Scotland, which, on the whole, is rather misty. The baths of *Moffat* and *Strathpeffer* are likewise available as climatic summer resorts.

In England, one of the highest of the available places is *Buxton*, in Derbyshire, about 1,000 feet above sea-level, and possessing tepid springs. The air is decidedly bracing, but would be better still on the neighbouring moors, which are merely used for shooting purposes. Similarly bracing air is met with near *Ilkley*, in Yorkshire, where the well-known hydropathic establishments of *Ilkley Wells* and *Benridding* are available to visitors, whether they undergo cold water treatment or not. *Harrogate*, well known for its springs, and also situated in Yorkshire, may likewise be recommended as a bracing summer health resort. *Great Malvern*, on the slope of the Malvern Hills, offers very good air, but is somewhat less bracing. The mountains and valleys of Wales contain various more or less suitable places. Most of them, however, are somewhat damp. *Llanberris*, near Snowdon, is one of the most bracing places, but is much frequented by tourists, whilst the Baths of *Llandrindod* and *Builth* are more quiet places. In the south of England there are many places of a moderately bracing character, on chalk or sandy soil, in the hilly districts of Surrey, Kent, and Sussex, particularly where these are clad

with pine woods; for instance, near *Weybridge*, *Leith Hill*, *Tunbridge Wells*, *Sevenoaks*, and *Hayward's Heath*; whilst in the south-west we have the district of *Dartmoor*, and, near the Bristol Channel, *Clifton* and its environs. These places have nothing in common with mountain climates, but belong to the climates of level countries, and they are noticed here only on account of their local connection with other inland climates of Great Britain.

The Cordilleras of America.

The long and high mountain chains of North and South America offer most extensive districts suitable for elevated health resorts. Within the tropics, and near them, the mountain regions up to 7,000 or 8,000 feet, even during the colder seasons, show temperatures which exceed those obtaining during summer in the temperate zone, so that only altitudes of from 9,000 to 12,500 feet are available for the treatment of consumption, whilst these conditions are modified in the same ratio as the distance from the equator increases, places of lower elevation thus offering climates favourable for the treatment of phthisis. The number of places possibly adapted to treatment by the climate of high altitudes being almost incalculable, a wide field is open here to the future. As yet only few places have come into general use.

Peruvian Andes: Jauja and Huancayo.

The mountain valleys of the *Peruvian Andes* have in this respect been known for long, and we possess a good deal of information on the *Valley of the Jauja River*, situated between latitudes 11° and 12° S. and longitudes 75° and 76° W. According to Archibald Smith ('Dublin Quarterly Journal,' May 1866), a good many places are scattered along the banks of this river at an altitude of from 8,000 to 10,000 feet, and slightly higher, of which the towns of *Jauja* and *Huancayo* are the principal health resorts for phthisical invalids from Lima. A. Smith gives the temperature of Jauja for the whole year as ranging between 50° and 60°, and of Huancayo, at a slightly lower elevation above sea-level, as between 51° and 63° F. He goes on to say: 'The sky is always clear and sunny, and the atmosphere pure and bracing, which invites to outdoor exercise and enjoyment.' In this valley the Peruvian Government in 1860 established a military hospital for consumptive patients from the coast, and par-

ticularly for Indians, who on the hot coast are specially prone to phthisis—a disease almost unknown in their native hills. According to Dr. Fuentes, a Peruvian physician, described by Smith as unbiassed, the proportion of the cured to the total number of patients in all stages of pulmonary consumption sent to Jauja amounts to the high number of 79 per cent. Our own experience comprises 14 consumptive patients, mostly in the second stage, with 2 in the first, and 2 in the third, who, coming from Lima, Callao, Valparaiso, and other commercial places on the same coast, had gone to the valley of the Jauja, and were all improved considerably, so that they could return to their occupations on the coast. As far as we could get information, 6 of them kept in good condition, 5 were repeatedly obliged to return to the mountain climates on account of relapses, 3 succumbed to the disease in Europe later on without having tried the mountain climates a second time, and of the 5 who repeatedly recovered there 3 have also since died, whilst 2 are still alive and may be considered as comparatively cured.[1]

Several of our patients have lived for some time in different towns of Bolivia, New Granada, and Ecuador: for instance, in Santa Fé de Bogotá (8,500 feet), at Quito (9,350 feet), and at Cuzco (13,440 feet), places which are likewise suitable as mountain health resorts. The table land of Mexico also offers several good places, particularly *Mexico*, the capital (7,466 feet), and *Puebla* (7,200 feet). Jourdannet's works furnish a good deal of information on the climates of Mexico.

Scrivener recommends the mountain regions of the Argentine Republic, and from Brazil consumptive invalids are sometimes sent to the eastern slopes of the neighbouring Cordilleras.

In the United States of North America several mountain climates have been extensively employed during the last 10 or 12 years, particularly in the State of Colorado on the eastern declivity of the Rocky Mountains, where *Manitou* (6,315 feet), *Colorado Springs* (5,775 feet), and *Denver* (4,350 feet) have become the chief resorts for consumptive invalids. Regarding these places, we refer to an

Rocky Mountains: Colorado.

[1] Several of these cases have been described in the *Med. & Chir. Trans.*, vol. lii., 1869.

excellent work by Dr. Denison, of Denver, on 'Influence of High Altitudes on the Progress of Phthisis,' Philadelphia, 1877; and a communication by Dr. Solly on Manitou (1875), and a short article by the same author in the 'Lancet' of 1877 (vol. ii. p. 256).

Manitou (lat. 38·5° N.; long. 105·5° W.) is situated in a valley on the plateau to the eastern end of the Rocky Mountains, close to Pike's Peak (14,300 feet), and six miles west of Colorado Springs. It is a little village possessing six mineral springs. From a table of meteorological observations given in the Reports of the Colorado Medical Society for 1878, and extending over the years 1872–1877, we abstract the following averages for Denver, the elevation of which is about 1,000 feet below that of Manitou:—Mean annual temperature 48·6° F.; mean temperature in December and January (the coldest months), below 32°; in July (the hottest month), 72·5°; mean daily range 28°, extremes in rare cases up to 54°. Relative humidity only 47·2; amount of rain and snow only 16·15 inches; number of rainy days 68, of which 40 are with snow. Clear days 147, fair days 159, and overcast days 65. Motion of air during the whole year on an average 51,550 miles. Hence we have a climate very moderate as regards mean temperature and characterised by great changes, with *very low humidity*, many clear days, and considerable motion of air. In Manitou the mean temperature is slightly lower, the protection from winds by mountains greater, the sun's heat more intense, so that invalids are on few days obliged to stop indoors. Several of our patients who had become acquainted with the Mediterranean resorts, and also with the climates of the High Alps of Switzerland, describe the climate of Colorado as particularly exhilarating. Autumn and part of winter are the best seasons, while spring, as almost everywhere, is changeable and disagreeable, on account of snow and thaw. Snow never keeps on the ground long, as at similar elevations in the Swiss Alps, and it is not so deep; while even in winter the ground is often free from snow. Many of the inhabitants of these already fairly populated places of Colorado belong to the class of those who have been cured of phthisis, or those who have a tendency to phthisis. Our personal observations are limited to 7 cases, of which 1 was in the first, 4 in the second, and 2 in the third stage; all im-

proved, 3 may be considered as cured, 1 as relatively cured, 1 as still being in good condition, 1 had a relapse some time afterwards, and 1 died eventually.

Colorado offers opportunities for removing to higher and cooler places during the heat of summer, and several of our patients spent there from three to six months, camping out in tents. We may hope that in the elevated regions of the United States of North America other climates, and even better ones than those of Colorado, will in time be available and will serve as resorts for many consumptive invalids or persons with a tendency to phthisis. Several places in *New Mexico* are already well spoken of, such as *Santa Fé* (6,846 feet) and *Albuquerque* (5,032 feet).

This hope is partly based on the altitude of whole territories which are about to be colonised. Thus, according to Toner's 'Dictionary of Elevation,' the average altitude of the state of Wyoming is 7,200 feet, the state of Colorado 6,500 feet, Arizona 6,000 feet, Idaho 5,800 feet, Utah 5,500 feet, Nevada 5,400 feet, New Mexico 5,300 feet, and Montana 4,500 feet.

Minnesota.

At moderate altitudes—for instance in the vast territories of *Minnesota*, United States, between 43° and 49° north lat. and 89° to 102° west long.—observations have likewise been made of the favourable influence which these climates have on consumptive invalids at the commencement of the disease. The average altitude of the state of Minnesota is 1,100 feet, that of St. Paul 800 feet, of Minneapolis about 780 feet, and of Winona 1,500 feet. The fact must, however, not be lost sight of, that the population of Minnesota is as yet very scarce, numbering only about 5 persons to the square mile (in 1870); so that an important element in the pollution of air is as yet wanting.

Asheville.

Dr. Gleistmann, of Asheville, North Carolina, United States, has drawn attention to the favourable conditions met with on the spurs of the Appalachian mountain chain in the western part of North Carolina, the north-west of South Carolina, and the north-eastern portion of Georgia. He recommends particularly Asheville, which is situated at 2,250 feet above sea-level, in 35° north lat., has a mean temperature

in summer of 70·7° F. and a mean winter temperature of 37·8,° with a moderate daily range, and an annual rainfall of about 40 inches ('Western North Carolina as a Health Resort,' Baltimore, 1876; and 'Biennial Report of the Mountain Sanitarium for Pulmonary Diseases, Asheville, N.C.', Baltimore, 1877).

South Africa.

Another region suitable for mountain health resorts is met with in the *Upland Country of South Africa* (to which, amongst others, Symes Thompson and H. Leach have drawn attention), comprising chiefly the Orange Free State, Griqualand West, the Transvaal, Natal, and Cape Colony. *Bloemfontein*, the best-known place, 4,750 feet above the level of the sea, is built in the centre of a plain bounded at a considerable distance by mountains. It has an invigorating, dry, and clear air, but is, according to H. Leach, very dull, offers but moderate accommodation, and can only be reached by a fatiguing land journey occupying from Cape Town about 10 days, not reckoning the sea passage. Summer is mostly hot and dry, while winter is cool and the relative humidity is below 60 per cent. The mean number of rainy days amounts to about 60, and the amount of rain does not, as a rule, much exceed 20 inches. There are English and German physicians in Bloemfontein, and, if only more easy of access, the whole district would offer favourable places for protracted or even permanent residence.

Kimberley, in Griqualand West, 4,400 feet above sea-level, and therefore slightly lower than Bloemfontein, is situated near the Diamond Fields, and offers similar climatic conditions. Its mean annual temperature is 63° F., the mean of the cooler months (October to March) being 55·3°, of the warmer ones (April to September) 70·6°; that of the coldest months (June and July) 48° and 49·2° respectively, and of the warmest months (December and January) 75·9° and 74·3°. The absolute maximum rises in four months to 102°, and in December and January it may be as high as 108°, while temperatures below freezing point are recorded from June to August. The mean relative humidity ranges from 50 to 70 during the warm months, and from 55 to 82 during the cold ones. As regards accommodation, Kimberley is, according to H. Leach, quite equal to Bloemfontein.

The Transvaal possesses, according to H. Leach, several places at elevations of from 4,000 to 5,000 feet which would be available as health stations if better arrangements were made for the reception of visitors. We mention *Christiania*, *Bloemhoff*, *Potchefstroom*, *Witwater Rand*, *Pretoria*, *Heidelberg* (5,400 feet), *Utrecht*, *Standerton*, and *Wakkerstroom* (6,000 feet).

In the colony of *Natal* better accommodation can be obtained than in any other part of South Africa: for instance, in *Colenso* (3,320 feet) and *Estcourt* (3,900 feet); but the summer temperature is very high, and the air is less dry than in the elevated places above mentioned. The same holds good for *Pietermaritzburg*, the capital (2,600 feet), and *Durban*, the seaport of Natal, which would not be suitable to invalids, except during two or three months in the winter.

Graham's Town (1,760 feet) and *Cradock* (3,000 feet) can also be recommended only for a short residence in the cold season.[1]

In the large district called *Kaffraria*, comprising extensive tracts of country between Natal and Cape Colony, there are, no doubt, many healthy places, but they are as yet not available.

In the case of those who travel to South Africa in search of health, it should always be considered that a long sea voyage, and also a land voyage, as yet involving much discomfort and expense, have to be gone through before the health resort is reached. Hence, although the climatic conditions are evidently good in themselves, only such patients should be sent there as possess a fair amount of strength. Moreover, delay at one of the seaports should be avoided. Those who land at Cape Town should as soon as possible proceed to the neighbouring *Wynberg*, provided they find room at one of the hotels, or to the more distant *Ceres*; whilst if Port Elizabeth be the landing-stage, they should get on to *Uitenhage*, and *Graham's Town*, or *Pietermaritzburg*, until the necessary arrangements for the inland journey have been concluded.[2]

[1] The altitudes given are mostly based on barometric measurements taken by H. Leach, and can only be considered as approximative.

[2] Africa possesses a mountain health resort also in its North, viz. Hammam R'Irrha, in Algiers, where a good hotel was opened some years ago, being

Asia, no doubt, offers many mountain districts suitable for climatic treatment, but, considering the long journey, it is not likely that patients will frequently be sent from Europe, England, perhaps, excepted, owing to its political relations. Space does not permit us to consider the mountain districts of Hindostan more in detail. We will therefore merely give a short notice of the principal mountain stations in the English possessions.

Darjeeling (lat. 27° N., long. 88° E.; 8,200 feet above the sea-level) has a mean temperature of about 44·5° F. for the winter, and of 62·5° for summer, the average rainfall exceeding 158 inches.

Simla, with a similar elevation, has a slightly higher mean temperature in summer, and a rainfall of about 71 inches.

Landour (7,870 feet) has a somewhat lower mean temperature in winter.

Murree and *Kussowlee* (situated on an isolated mountain), *Dugshai* and *Nynee Tal*, all in Bengal, range in height between 5,900 and 7,900 feet.

Outacamund, *Kotagherry*, and *Wellington*, in the Neilgherry mountains, situated between 11° and 12° north lat., at altitudes ranging from 5,600 to 7,900 feet, have mean temperatures similar to Darjeeling, but only half the amount of rainfall.

Palneyo, in the Presidency of Madras, is 7,550 feet above the sea; *Shexaroys*, *Mercara*, and *Namendroog*, also in Madras, are from 2,600 to 3,300 feet lower.

Abu, in the Aravelli mountains (24° north lat.), *Mehablishwur*, and *Poorandhur*, in the Presidency of Bombay, are between 4,000 and 4,500 feet above the sea.

It is important to bear in mind that these mountain stations of India differ greatly in their climatic conditions from similar regions in Europe, America, or South Africa. They are situated partly on the southern declivity of the Himalayas, and partly on the great peninsula to the south of the mountain range. Their climates are determined, first of all, by their proximity to the equator, owing to which the climatic effects of high altitudes

specially arranged for the reception of winter visitors. It lies 2,000 feet above the sea, sixty miles west-south-west of Algiers, has a good climate, and is particularly recommended for convalescents from gout and rheumatism. For consumptive invalids it is not suitable, owing to the shelter from winds not being sufficient.—*Tr.*

are considerably modified; and secondly, by the large and warm tracts of water by which the peninsula is surrounded. The periodical winds blowing from these are saturated with moisture, which they deposit in the form of copious rain on coming in contact with the cooler mountain regions. Owing to the high temperatures prevailing, the vapours rising from the moist soil must be mixed with organic products even at places where malignant malarial fevers are not endemic, and the absolute humidity of the air must therefore be higher than in the mountain valleys of the Andes, the Rocky Mountains, or of the Swiss Alps. Hence the air at places like Simla and Darjeeling will not be so aseptic as we found it to be at the elevated health resorts of the mountain ranges just mentioned. Notwithstanding this, the Indian mountain stations have many advantages over the lowlands of India, and are therefore of incalculable utility to that country. Moreover, the valuable statistics collected by E. G. Kellet regarding the influence on phthisis pulmonalis of a long sojourn in the convalescent station of Landour have shown favourable results, as far as can be concluded from the comparatively short stay which such stations for military convalescents permit.

On the northern slopes of the Himalayas totally different climatic conditions will be met with, owing to the fact that the air currents coming from the sea have discharged the greatest part of their moisture over the high mountain tracts. In accordance with this, the elevated regions of Kashmir, between the 33rd and 34th parallels of latitude (as has also been pointed out by Biermann), possess climates which in point of agreeableness far surpass those of the Rocky Mountains and the Alps, and would probably come very near to them as regards curative properties in the treatment of consumption. However, in the fine mountain valley of Kashmir, the mean elevation of which is supposed to be about 6,500 feet, the summer temperatures must be very high, judging from the culture of rice and other vegetables; so that in summer consumptive persons would have to migrate to cooler regions.

The mountain regions of Australia and New Zealand will be passed over entirely, as their climates have been but little investigated.

II. The Climates of Low Levels.

Having ranged so many places in the different groups of sea, coast, and mountain climates, we may more briefly consider the low-lying places of inland countries. In dividing them into comparatively dry and moist climates, we have to bear in mind that every division is arbitrary, and that dry climates are *more bracing*, whilst moist climates are *more sedative*. The comparatively dry climates may be subdivided into *dry and warm* and *dry and cold* climates.

Dry and Warm Climates.

The deserts of Africa.

It is in the *Deserts of Africa* that we meet with the typical *dry and warm* climate—great heat and dryness of the air in the day-time, and a considerable fall of temperature or actual cold at night, a clear sky, infrequency of rain, and often much dew. This typical climate, i.e. the desert, is, generally speaking, as yet not available; we have, however, met with several consumptive invalids possessing an unusual amount of energy and independence, who, although having cavities in the lungs (in the case of one patient complicated with albuminuria), spent years together almost entirely in the desert under tents, got their food chiefly by shooting, and did very well in this way until they—the one sooner, the other later—became tired of this existence, enforcing complete isolation from social and mental attractions, and returned to their homes, where they succumbed to the disease. It stands to reason that the climate of deserts, in spite of the great heat, is aseptic no less than that of glaciers and regions of perpetual snow; the invalids just mentioned also found that wounds, as inflicted by cuts or other little accidents, healed remarkably quickly.

Nubia.

The climate of *Nubia* having many points in common with the pure desert climate, is very agreeable during the cooler months, as we have been informed by several invalids who had travelled about much. They spent in Nubia the months of December, January, and February under tents,

having left Italy in October, and returning to it some in April, some by means of a circuitous route in May. According to them, the sanitary condition of the Nubians is most satisfactory, consumption being rare. Our patients did very well in Nubia, but in two of them the homeward journey on the Nile did some harm, and another patient became worse on arriving in Italy. It may be questioned whether residence extending over years would not be beneficial, notwithstanding the hot summers.

A *Nile voyage* with a stay in Upper Egypt brings patients under similar climatic conditions; it is, however, not without danger, owing to the nights being often cold on board ship, and therefore great care and an abundant equipment with articles of dress and food are necessary. Further drawbacks are the occasional occurrence of dust-laden winds, annoyances in dealing with the dragoman, and other troubles. Only in exceptional cases should patients in an advanced stage of disease travel up the Nile, and these not without being accompanied by a medical man, and only in the period from December to February.

Cairo.

Cairo (lat. 30° 5′ N. and long. 31° 19′ E.), with its surroundings, may be considered as a type of the more accessible dry and warm climates. Still, the yearly percentage of atmospheric humidity at Cairo is not so low as is generally assumed, the relative humidity being occasionally in the winter months (with which we are chiefly concerned) as high as 80, and averaging between 60 and 70. Bearing in mind the high temperature of the air, it stands to reason that the absolute amount of moisture contained in the air (at Cairo) is rather large, much larger, for instance, than at the mountain resorts on the slopes of the Rocky Mountains (cf. p. 200) or even at Davos. In considering the influence of the air on the organism, and particularly on the lungs, we must, as previously mentioned, take notice not only of the relative, but also of the absolute humidity of a given place, and this fact illustrates one of the many weak points in our system of division of climates. The advantages of the Egyptian climate (that of the neighbourhood of Cairo being generally understood in this expression) may be enumerated as chiefly in a clear sky, much exposure to the sun, and longer duration of sunshine in winter,

compared with more northerly regions, and in the opportunities enjoyed by invalids for spending almost the whole day in the open air. They may be out from soon after sunrise almost until sunset, which would allow them from six to eight hours even when the days are short, rain falling but seldom and never lasting long. The sky being cloudless, it follows that radiation at night is very considerable, as also the difference of temperature between day and night. There is, however, a want of uniformity even during the day, and winds are not rare, although the hot and sandy Khamsin (S. and S.E.), which is very trying and dangerous to invalids, does not set in before April. At this time of the year invalids ought to have left Egypt, the season during which it should be visited extending from mid-November to mid-March, and only in exceptional cases from the beginning of November to the end of March. Hence great care cannot be dispensed with even in Egypt, particularly with reference to clothing, bodily exercise, and excursions, and invalids should have strict rules laid down for them by their medical advisers. The fact that the rate of mortality is high among the inhabitants of Cairo (1 per 21 or 22) should not keep anybody from resorting to this climate, but shows that hygienic rules must not be lost sight of.

About 15 miles from Cairo lies *Heluan*, which may be called a sanatorium of Cairo, possessing hot baths and satisfactory accommodation. It consists of an hotel and a few houses built on an artificial oasis in the desert, whence it enjoys a remarkably pure atmosphere, being free from the contaminations inseparable from a large town like Cairo. The stations to be visited before and after the wintering in Egypt, and the whole arrangements of the voyage, require special consideration in each individual case.

Our personal experience with regard to the influence of Egypt is limited to 24 phthisical patients, who spent from one to four winters in Egypt. Of 6 in the first stage, 4 improved, and 2 became worse; of 12 in the second stage, 6 improved, 3 remained stationary, and 6 became worse; of 6 in the third stage, 2 improved, 1 remained stationary, and 3 became worse. Cases of emphysema and chronic catarrh did very well: namely, 9 improved out of a total of 10; of 16 cases of chronic rheu-

matism, 14 were improved or cured; and of 9 cases of gout, improvement took place in 8. Several cases of chronic diabetes occurring in middle or advanced age were benefited; and of 11 cases of albuminuria, recovery took place in 1, improvement in 4, the disease did not make any progress in 4, whilst in 2 it advanced, and in 1 ended in death. Cases of heart disease with a tendency to catarrh of the bronchi and dyspepsia did well. Neuralgic cases were benefited, and so was premature senility, and nervous exhaustion arising from incessant mental labour or anxious cares in business.

Dry and Cold Climates.

Dry and cold climates of low levels.

The dry and cold climates of low levels have as yet but rarely been utilised in the treatment of disease. We have, however, notes of four cases of phthisis in the first and at the beginning of the second stage, occurring in missionaries and clerks whom we had advised to accept places offered to them in *Labrador*. Three of these patients, whilst residing there, made a complete recovery in the course of 4 or 6 years, and were examined whilst visiting Europe occasionally, whilst the fourth patient became so depressed, owing to the long winters and short days, that he had to return home neither better nor worse, and there succumbed to the disease three years afterwards. We must add that all four were originally of strong physique and possessed a good circulation; they were also free from any other organic disease, and hereditary predisposition in them was either absent or only present to a limited extent. As, in our opinion, it is only when such favourable conditions are present that a trial of similar climates can be recommended, we have strongly dissuaded several weakly persons with bad circulation, deficient assimilation, and inability to bodily exertion, from resorting to them. Hence it will be seen that the favourable results mentioned refer merely to selected cases.

Many continental climates must, during the winter months, be classed among the *cold* and *dry* ones; for example, several large districts in North America, especially in Canada, where the ground is mostly covered for months with snow and ice.

Practitioners coming much in contact with persons who, owing to business transactions, have to resort to such climates for a number of years, have occasion to observe at times striking results in cases where there is a tendency to phthisis and to disturbances of nutrition; but, as yet, it is scarcely possible from this to lay down general rules for the treatment of disease by this kind of climate.

Moderately Moist Climates.

In using the term 'moderately moist' we wish to exclude climates that are actually damp, these latter being available only in exceptional cases. For the damp and hot climates are hot-beds of malaria, whilst the damp and cold ones often give rise to rheumatic and catarrhal affections in constitutions not endowed with exceptional power of resistance.

Amongst the moderately moist (or, rather, less dry) inland climates the first to be considered are the comparatively warm ones which are available as winter health resorts—*Rome*, *Pisa*, and *Pau* being the most known. The climates of these places are frequently described as equable, warm, calm, and moist, with mostly a dull sky, but this description would give one a wrong idea, and the exceptions may be said to be so frequent as almost to outweigh the rule.

Rome.

Rome (lat. 41° 53′ N., long. 12° 28′ E.), the city with seven hills, is situated in the midst of a plain surrounded by mountains to the N.E. and S.E., which do not afford much shelter, being distant from 7 to 11 miles. The mean temperature of the winter season (November to April) is about 50° F., the number of rainy days during the same period averaging from 60 to 70, and the relative humidity from 60 to 75. Rome is somewhat warmer than Pisa or Pau, and shows, at the same time, a greater range of temperature; the N.W. is often very cold and violent (Tramontana), but the sky is on many days quite clear, and the climate more invigorating than at the places just mentioned, whence it may be considered to be midway between the sedative and stimulating climates. Dr. Erhardt, in the 'Berliner Klinische Wochenschrift,' in 1875, has given practical hints containing much information on the

climate of Rome, and its suitability in particular cases. Rome is not adapted for patients in an advanced stage of disease, partly on account of the impurities in the air always present in large towns, partly owing to the great changes and the absence of sheltered walks, partly also owing to the temptations afforded by historical monuments and art treasures. This last circumstance, on the other hand, helps to make Rome an eligible resort for many persons who are mentally depressed or suffering from nervous complaints; also for those who are exhausted by over-work or who are prematurely senile. Patients with heart disease, too, generally do well if they avoid as far as possible the stairs always encountered in visits to museums. The dreaded Roman fever, as shown by Pantaleoni, Erhardt, Aitken, von Fleischl, and other physicians, is a malarial fever endemic in the Campagna, and making Rome unsuitable from May to October, and in particular between June and October, but being hardly to be feared in winter. Typhoid fever is not absent from Rome, but it is much less frequent than is generally assumed, and may mostly be avoided by using ordinary care as to sanitary conditions and diet.

Pisa.

Pisa (lat. 43° 48′ N., long. 10° 23′ E.), 164 feet above the level of the sea, is situated about six miles distant from the Mediterranean, and its climate is intermediary in character between inland and coast climates. It is not so sheltered and calm as is frequently assumed, the chain of the Apennines being too far distant and the Pisan Hills leaving a gap to the east through which the Arno flows. The mean temperature in winter (November to March) is 47° F., being from 2·5 to 3·5 degrees lower than on the western Riviera; the temperature in the three coldest months (December to February) averages about 45°, but often sinks below the freezing point when northerly or north-easterly winds prevail; on the other hand, the mean daily range of temperature is moderate. There are 63 rainy days from November to March, and the annual fall of rain amounts to about 51 inches; the relative humidity in the winter season varies from 70 to 85 per cent., and the vapour pressure from ·23 to ·27 inch. Generally speaking, it may be said that Pisa in the winter season is moderately moist, fairly equable in temperature, and moderately free from

winds. The sky is not seldom cloudy, but there are almost no fogs. Pisa is not free from dust, and does not offer many opportunities for outdoor exercise; the best shelter is to be found on the Lung-Arno Reale, and here also the dwellings are most exposed to the sun. More detailed information may be found in the works of Sigmund, Felice, and Bröking.

Pau.

Pau (lat. 43° 17′ N., long. 22′ E.), 650 feet above sea-level, is situated on the north of the Pyrenees, the view of which forms one of the attractions of the place. It is tolerably protected on the north by a series of hills, and partly also on the east and west; the air is, as a rule, fairly still, but at times strong currents make themselves felt. Owing to the influence of the Atlantic, Pau enjoys a soft and temperate climate, its mean temperature for the winter months (November to April) averaging from 43·7° to 45·5° F., while the daily range rarely exceeds 16°. The number of days on which either rain or snow falls during the said months varies from 80 to 90; the sky is often cloudy, and the mean relative humidity averages from 80 to 85. The ground dries quickly, dust is rare, there are many opportunities for taking outdoor exercise, the sanitary condition is satisfactory, the accommodation excellent, and first-rate medical advice is available.

The climate, though less invigorating and affording less sunshine than that of the western Riviera, is more equable. Generally speaking, it is more suited to persons of an excitable disposition, those inclined to nervous affections or suffering from irritability of mucous membranes and subject to a dry cough or liable to become feverish from slight causes, whilst those in want of much sunshine and persons of a torpid habit generally do much better on the Riviera.

The observations of Drs. C. J. B. and C. T. Williams on the influence of phthisis are less favourable for Pau than for the Riviera and other stimulating climates.

Amélie-les-Bains.

Amélie-les-Bains (lat. 42° 25′ N., long. 2° 12′ E.) is frequented fairly well in winter, and its climate is intermediary in character between low-level and mountain climates. It lies at an elevation of 920 feet above the sea on the river Tech, in the Eastern Pyrenees. It is well sheltered on the north, north-west, and north-east, but open on the east,

and has an advantage over Pau as regards the number of clear days; but its daily range of temperature is greater, and may amount to 20° or even 30°. The time during which it is exposed to the sun is somewhat curtailed by the surrounding mountains. It is, therefore, only in exceptional cases suitable for winter, whilst for the autumn it is of great value, more particularly in cases of rheumatism or of throat disease, owing to its excellent sulphur springs.

Palalda.

Somewhat lower down in the same valley we have *Palalda* (730 feet), which might in time become a more frequented winter station, to judge from the cultivation of pomegranate, olive, and fig trees, which points to the prevalence of higher temperatures and of higher minima.

Comparatively Cool and Moderately Moist Places.

There are many climates intermediate between the moderately warm and moderately moist stations on the one hand, and the comparatively cool and moderately moist ones on the other. These might be called *neutral* climates, inasmuch as neither warmth, nor relative humidity, nor barometric pressure give them a well-defined character. They are mostly available in late spring and early summer, and late summer and early autumn, being too hot for most invalids during midsummer, while they are too cold and changeable in winter. Their relative humidity, more particularly at midday, is comparatively low in the seasons during which they are frequented, owing to the higher temperature of the air, whilst in winter it is rather high, and varies considerably. Under this group a good many places may be classed, which, being situated in lower mountain valleys, and in the outlying mountains, have been noticed above under the mountain climates or climates of the lower Alps, and also most of the English inland health resorts. No clear line of demarcation can be drawn between them. Most of the places in vogue owe their character as health resorts to the presence of mineral springs or hydropathic establishments, and to the facilities thus afforded regarding accommodation; whilst their climatic characteristics hardly give them an advantage over neighbouring places which are seldom used or but little known.

Every practitioner can find places either in his immediate neighbourhood or at no great distance which might be used with great advantage for different classes of cases, according to the aspect of the place, its altitude, nature of soil, the proximity of forests, inland lakes and rivers, and according to many other conditions. It is important, first of all, to become acquainted with the atmospheric conditions, to consider every possible source of impurity, and to have regard to dryness of soil, good drinking water, well-ventilated dwellings, and satisfactory food. Attention must also be given to the exposure of the place to the sun and the easy accessibility of shady walks in summer: in short, to the opportunities which, according to their strength, invalids will have to spend the greater part of the day agreeably in the open air.

A great many inland and woodland resorts might thus be found which would be of great advantage to townspeople, and more particularly to children, young people, and convalescents. It will frequently be seen, and more particularly in cases of great debility, that more benefit, with less risk, can be derived from resorting to places near at hand than if distant places are resorted to, necessitating a fatiguing journey. There are but few towns in the neighbourhood of which places suitable according to the patient's condition could not be found, if a proper search be made. Wherever arrangements are imperfect, medical advice must step in to bridge over defects by teaching how to make use of the existing advantages. Places like Baden-Baden, like Wiesbaden, Soden, Gleichenberg, or Schandau, owing to their social attractions, the first-rate medical advice they offer, and their good hotels, have advantages for many persons, particularly if distractions are important to them, whilst simple rural conditions are preferred by others. These are met with, together with fine scenery and pure air, at a good many places, and every country possesses a greater or less number of them. Taking the case of Germany, we have only to look to the strip of country between Frankfurt and Heidelberg, where *Jugenheim*, *Zwingenberg*, *Michelstadt*, *Erbach*, *Auerbach*, *Bensheim*, *Weinheim*, and many other places are very agreeable for residence. On the *Neckar*, the *Main*, *Nahe*, *Lahn*, *Mosel*, and in many lateral valleys of the *Rhine*,

in the neighbourhood of the *Teutoburg Forest* and of the *Weserberge*, a great many suitable places are offered to persons whose requirements are moderate. Even below Cologne there are several good places slightly elevated above the plain of the lower Rhine; for instance, *Cleve*, which is situated in the midst of vast forests. It can scarcely be sufficiently pointed out how much benefit may be derived in the treatment and prevention of many chronic affections from a sojourn at these unpretentious places, and that this advantage may be gained without spending much money.

III.

THE CHOICE OF A CLIMATE FOR THE TREATMENT OR PREVENTION OF DISEASE.

Physicians who are frequently consulted about the choice of a climate often experience a difficulty in their dealings with patients owing to misconceptions prevalent among the general public. As a rule, the disease—say phthisis—is considered as something specific and fully explained by its name, whilst the climate of a given place is also supposed to have a specific and unvarying action, according to which it may be prescribed like a dose of medicine. The invalid and his friends sometimes even become impatient if the physician makes a thorough examination, or if he enquires into details as to how and where the disease arose, to what extent family predisposition is present, and as to the constitution and temperament of the patient. And yet these points are of the greatest importance in almost all cases, for the mere name of the disease but rarely affords a sufficient clue, and regard must be had to its stage and complications, the mode of origin, and the length of its existence, the manner in which it has been progressing, and the tendency it shows to further advance or to arrest; then the constitution of each patient has to be considered, how far he is able to exert himself and to resist influences from outside; and finally, attention must be paid to his temperament, and in what way this will be affected by certain social and climatic conditions. We have invariably to deal with *chronic* diseases, or with tendencies which, as a matter of course, are always of a *chronic* nature. Cases do occur in which treatment by medicines has been carried on patiently for years, but without advantage; while

'climate' is expected to effect a cure in the course of a few months, or perhaps weeks. Other points which are also frequently lost sight of are, that the climate of any place is the result of various factors, subject to continual changes, that we are frequently unable to foretell what the nature of these changes may be, and that for this very reason it is difficult to say what the influence of a climate will be on any given case.

Hence in many cases it is not very easy to recommend a climate; and even after the most suitable place has been selected, much more remains to be done in most of the cases. For, in order to benefit the patient, the constant supervision of an intelligent physician is necessary; without it, the agreeable properties of a climate may become the sources of the greatest danger, whilst, with it, the drawbacks are as far as possible avoided and the advantages made use of.

No climate is perfect: some climates have drawbacks in one, others in a different direction; most climates vary a good deal at different times of the year, and are suitable for certain affections only at particular seasons, owing to the more or less complete absence of its usual drawbacks. What constitutes a good climate for one class of cases does not equally apply to another. That climate is a good one for any given class of cases in which the qualities which would be disadvantageous are to a certain degree absent during the whole year, or at least part of the year, whilst other qualities are present by the proper use of which the bodily strength is raised and the restoration of the affected organs and functions is facilitated. Pure air, opportunities for spending much time in the open air, and good hygienic and dietetic conditions are necessities; the presence of a good physician is of great importance; and a certain harmony existing between the patient on the one hand, and the social and physical conditions of the health resort on the other, is in most cases a powerful auxiliary. It is only in a few cases that the meteorological conditions alone are sufficient; the situation and the arrangement of the residence, the clothing and food, the amount of outdoor exercise, and the best time of the day for it, require in each individual case thorough consideration by the physician, and adaptation to

A good health resort.

the climate in question, which must not be regarded as constant, but as continually changing.

A good health resort, particularly if frequented by invalids at rather advanced stages, ought to possess the following advantages: verandahs which can be opened or closed at pleasure, suitable walks for taking outdoor exercise provided with comfortable seats and also with seats having high backs which can be turned to provide shelter from the wind, resting-places both in sunny and shady spots, hammocks, wheel chairs for invalids, donkeys and horses suitable for riding.

In ordinary treatment, either by medicine, or baths, or in regulating the diet, we have always to consider whether the constitution of the patient is torpid, the tissue change sluggish, and the functions difficult to stimulate, or the opposite condition obtains; or whether one of the many intermediary states is present. Our treatment must be modified accordingly. In recommending a climate we must bear in mind what are the principal peculiarities of each constitution, and send one patient to a more stimulating, the other to a more sedative climate.

In treatment by climate, as in every other treatment, it is a most important point, whatever be the disease, to know as accurately as possible the amount of strength possessed by each patient, and the ease or difficulty with which reaction is induced. In the case of torpid constitutions with a fair amount of strength, low temperatures with a dry air act most beneficially, whilst 'erethic' constitutions with a deficient reactionary force are, as a rule, unfavourably affected by the same meteorological conditions. In the former they increase the appetite and the state of nutrition, and stimulate the functions generally; whilst in the latter, they diminish the appetite and paralyse nearly all the functions. It is only in a few striking cases that we are able to recognise the patient's condition, and give suitable advice off-hand; the majority are so complicated, that an opinion is not easily formed. Whilst some peculiarities of a climatic health resort are favourable, others may be injurious; so that only a careful trial can decide which particular resort (or which class of places) is suitable and how long it will remain so, and when a change of climate will have to be made. Other

cases, again, are of such a character that they may be dealt with in more ways than one, and that a cure may be effected in a great variety of ways.

ENUMERATION OF CASES.

As the principles of the climatic treatment of individual cases have already been treated in the sections on the elements of climate and on special climates, we may here be brief, and, instead of enumerating all the health resorts, quote only a certain number of them as types.

Diseases of the respiratory organs, and more especially cases comprised under the term of phthisis, have formerly been almost the sole objects of treatment by climate. Although this is no longer the case, they still occupy the most prominent position among the diseases treated by climate, and are also entitled to the first place, for this reason, because the principal element of climate—the air—comes into direct contact with the respiratory organs, and as to them the saying is chiefly applicable 'Pure air beyond everything.'

Diseases of the respiratory organs.

1. *Bronchial Catarrh*, including chronic bronchitis. It is a common experience that cold together with dampness, particularly if winds and sudden changes supervene, are frequent causes of catarrh; also, that these are due to the climate, and that a warmer and moderately moist air frequently causes quick recovery, whilst long-continued and hurtful climatic influences lead to chronic catarrh, so called winter cough, and to bronchitis and emphysema, with amelioration in the warm season of the year and exacerbation in the cold. The following climates are chiefly indicated: in winter, warm and equable climates; the dry ones, like Egypt or the Riviera, if there is much discharge; whilst the moist ones, like Madeira, Pau, or Pisa, may be recommended if the discharge is scanty; in summer, on the other hand, sea climates or mountain health resorts at moderate elevations, such as Weissenburg, Badenweiler, Reichenhall, or also neutral climates like Gleichenberg, Soden, Wiesbaden, Ems, and Baden-Baden. Improving the tone of the skin by baths and exercise is an important adjunct.

In the case of complication with affections of the heart, the latter are often the causes of catarrh, and require attention accordingly.

Uncomplicated catarrh of the bronchi is in most cases also benefited by mountain climates. Should, however, a regular winter cough have developed, mountain climates are unsuitable, owing to the state of the lungs. No place with more pronounced mountain climate than the summer stations in the Lower Alps with pine woods and shelter from winds should be recommended, and even these only in mid-summer, whilst for the early and late part of summer the warmer of the neutral places, or some climates in the outlying Alps, are suitable.

2. *Emphysema*, being partly due to the same causes as chronic catarrh of the bronchi, is not adapted for mountain climates, and requires warm winter health resorts, which may be either of the comparatively dry or moist class, according to the constitution of the patient. For summer treatment similar places to those suitable for chronic catarrh.

3. *Laryngeal Catarrh*, if uncomplicated, presents the same indications as bronchial catarrh.

4. Cases of *Bronchiectasy* require in winter comparatively warm and moderately moist climates, such as the Riviera from Hyères to Pegli and Nervi, or Ajaccio, Palermo, or Algiers; whilst in the latter part of spring and in the early summer or the beginning of autumn, neutral climates, or places in the Lower Alps, such as Baden-Baden, Bex, Montreux, or Pallanza, are indicated; and in summer, mountain stations of moderate elevations may be recommended like Badenweiler, Reichenhall, and Ischl, or the seaside resorts on the south or east coast of England, or on the north coast of Germany, Holland, or France, and also on the Baltic.

5. Cases of *Asthma*, associated with uncomplicated bronchial catarrh, without heart disease (asthma catarrhale), quickly improve, as a rule, at mountain stations, although in some cases (in general feebleness) the warmer climates are better suited. The dry are indicated when the secretion is abundant, the moderately moist ones, such as Arcachon, when it is scanty, or the moist climates like Pau and Pisa.

The catarrhal affections of the respiratory organs, owing to

the influence they exert on the whole constitution by altering the respiratory processes, and owing also to the secondary affections caused by their neglect, are of such importance that they require at an early stage the most careful attention by the physician, and the patient himself. Climatic treatment ought to be commenced without sending the patient far from home, and should include hygienic and dietetic treatment. These catarrhs, it is true, frequently form part, or are the results of, constitutional and organic defects, thus admitting only of palliative treatment, by climate or otherwise. But in many other cases, if all the climatic conditions are well studied, and the patient's life is regulated according to them, attention being at the same time paid to clothing and dwelling, it is possible to harden and strengthen the patient's constitution to such an extent, that he becomes used to the vicissitudes of the climate of his home. The treatment of catarrh is a true test of medical skill, and every physician ought to direct his full attention to this not at all unimportant duty.

6. *Phthisis and Pulmonary Consumption.*—Were we to write a special work on phthisis, we should now pass in review the affections of the different parts of the respiratory tract, such as of the larynx, the trachea, of the apices and bases of the lungs, and of the pleura. As, however, all these states, if of chronic nature (and it is only with these that we here deal), under unfavourable conditions lead to certain forms of phthisis; as they can only with difficulty be distinguished from phthisis, and as this disease often begins to manifest itself through them; and as, finally, they all require similar climatic treatment, we shall consider all these states, so far as they have a tendency to end in consumption, under the term of phthisis, or pulmonary consumption. We are well aware of the circumstance that consumption is not in all cases merely an affection of the lungs, but as its principal symptoms proceed from the lungs, we shall consider it under the pulmonary affections.

For accounts of the complicated pathology of phthisis we refer the reader to the excellent articles on this subject in Ziemssen's Cyclopædia, and also to the works by Virchow, Buhl, Rühle, Rindfleisch, Williams, Walshe, Wilson Fox, and others; whilst as to the treatment of phthisis by climate, we

refer to the practical account given by Rohden in Braun's 'Curative Effects of Baths and Waters,' and also to the works, already repeatedly cited, by Williams, Mac Cormac, Thorowgood, Biermann, and others. The subject is so wide, that we can hardly go beyond a few aphoristic observations. In discussing the relation of pulmonary consumption to climates of high altitude, we pointed out above, that much as cases of phthisis, and affections of the respiratory organs in general, may differ as to origin, stage of disease, and its complications, we have to bear in mind that we have to deal with irritated, or ulcerated, or suppurating surfaces, which are easily affected by every impurity of the air, and heal best in a pure and comparatively aseptic air. This pure air is not to be found in densely populated places, nor in small and badly ventilated rooms, but it is met with to a certain extent in elevated regions, provided they are uninhabited, far away from noxious emanations, and free from dust; on the sea also; to a certain extent, on the sea-coast, and in the desert; in the country, more in open fields or under tents than in the interior of houses. Formerly climates possessing warm air and small fluctuations of temperature, were deemed to offer the best conditions for the cure of phthisis, but experience has not confirmed this. Much stress was laid on the allaying of cough, which is best effected by climates having a warm and moist air, but a cure or prevention of phthisis is quite as little effected by them as by morphia. Warmth, cold, light, and sunshine, certain conditions of atmospheric pressure, of moisture, air-currents, and electricity may be useful, and according to the nature of the case, either one or the other of these factors is so particularly; but purity of the air is the most important condition. Had we a simple test by means of fermentation and the microscope, which would enable us to ascertain the purity of the air, it would be easier to judge of the effects individual climates have on the respiratory organs.

It is often very difficult to decide whether mountain stations, sea, or low-level climates should be selected. Many simple cases in the first stage may, under appropriate and long-continued treatment, get well either at high altitudes, or on the sea, or coast; whilst many of the advanced cases, or of those

in early stages, but taking a rapid course, will not recover anywhere. In a good number of cases it is easy to decide, owing to the presence of pronounced constitutional peculiarities, inasmuch as individuals of a nervous inflammatory type (who are not able to resist external influences) do not tolerate mountain climates, particularly if combined with low temperatures, and have better prospects in sunny and warm places; whilst persons of a leucophlegmatic diathesis, and those who are able to resist extremes of climate, have a decidedly better chance of recovery at high altitudes. Again, there are others who, during part of the year, or during a certain period of their illness, receive the greatest benefit from a mountain climate, whilst under different circumstances they do better at the seaside. It is often the case that a neighbouring climate, whether sedative or neutral, has first to be employed before removal to a more distant and more extreme climate—whether mountain or sea, cold or warm—can be decided upon.

When speaking of the effects of sea climates, and climates of high altitude, we gave an account of our personal experience. If we comment now upon several states more in detail, we are well aware of the fact that in ordinary practice uncomplicated cases are not exactly the rule, but that different forms of disease, and different stages, frequently occur simultaneously in the same individual. In the following remarks we shall not repeat the contraindications against climates of high altitude given above.

1. In *Apex Catarrh*, either the simple chronic catarrh, or if associated with peribronchitic processes, the warm, moderately dry, and rather moist winter resorts of the Riviera may be advantageously ordered, as also Ajaccio, Palermo, Algiers, and Cairo, or climates of high altitude, such as Davos, St. Moritz, Colorado, Görbersdorf, or Falkenstein. After the winter has been spent at a warm place, sheltered climates of the Lower Alps may be recommended in spring, such as Pallanza, Bex, or Montreux; whilst in summer mountain climates at different elevations, or moderately cool sea climates, may be selected. The time required for treatment varies greatly according to the degree of the affection and the length of its existence, and may range from a few months to several years. Even after

complete recovery relapses take place easily under unfavourable circumstances. Those who are cured should carefully avoid sedentary habits, particularly in an impure atmosphere; should spend much time in the open air, and pay attention to physical exercise, hardening the constitution and sustaining the strength; and they should frequently resort to the seaside or to mountain climates, where they may engage in moderate climbing. Regular pulmonary gymnastics, friction with a wet towel, or douches, should in almost all cases form part of the daily routine of life.

2. In *Chronic Apex Pneumonia* a similar treatment is indicated, but in most cases it must be carried on for a yet longer period, and does not admit of a prognosis quite so favourable. Under the most favourable circumstances it leads to shrinking and cicatrisation, that is, to loss of lung substance, the tendency to fresh affections being great even after a cure has been effected. Hence the hygienic and climatic treatment, as above described, must be carried on for many years.

3. *Residua of Acute Pneumonia*, evidenced by dulness, catarrh of the region which was formerly invaded by the acute process, and by impaired breath sounds, possibly accompanied by a rise of the evening temperature and occasional night sweats, allow of a similar climatic treatment, though in this class of cases mountain climates are generally to be preferred. The prognosis is mostly favourable.

4. *Residua of Pleuritic Effusions.* In incomplete absorption of the exudation, unless tapping is indicated, suitable seaside places may be ordered, including the cooler ones, such as those of the English south-west coast and of Ventnor, and also mountain climates. In later stages, however, that is, after the disappearance of all the acute symptoms, the best and promptest results are, as a rule, obtained at climates of high altitude.

5. The diagnosis of *Caseation* of inflammatory products (tyrosis) can only be made approximately. When, owing to the accompanying processes, a more or less continuous fever is associated with it, warm and moderately moist sea climates are indicated during the cold season, such as Algiers, Palermo, Ajaccio, Mogador, Tangiers, while in summer the cooler seaside

places or mountain stations of medium elevation are to be selected. At a later period, when the fever has disappeared, and cavities may have formed, unless the loss of lung tissue be great, elevated districts are generally more suitable than warm seaside places. The treatment must be carried on for several years, and if the original process extended over a wide area of the lungs, the patients in question, although cured, always require prophylactic treatment, thus remaining invalids more or less.

6. In extensive *Catarrhal-Pneumonic Phthisis*, without appreciable loss of lung tissue, the following climates are indicated: at the beginning, if the secretion be abundant, dry and sunny seaside places, such as the Riviera; if it be scanty, moist climates, as Madeira; sheltered places possessing pinewoods, as Arcachon; in summer, stations at medium elevations, such as Badenweiler or Weissenburg. After the more acute stage has ceased, the indications are different, and mountain climates may be selected. A guarded prognosis should be given as long as there is much rise of temperature. When, however, the temperature is no longer high, the prognosis is more favourable, and then mountain climates may be recommended.

7. In extensive *Active Phthisis*, attended by the formation of cavities, the prognosis is always uncertain. Warm and well-sheltered sea climates with much sunshine, like Mentone, are the best in the circumstances, and the journey ought to be made as easy as possible, whilst the preference should be given, *ceteris paribus*, to the most accessible place. Mountain climates are not to be recommended.

8. *Acute Tubercular Phthisis* admits only an unfavourable prognosis. No distant health resorts should be recommended, but arrangements should be made to place the invalid under conditions as favourable as possible, either at his home, or at a place near it, so that death may not be aggravated by the feeling of being left alone and by privations of all kinds.

9. Patients with a tendency to *Hæmoptysis* may occasionally be sent on sea voyages or to sea climates, but in the early stages of hæmorrhagic phthisis the tendency is more efficiently counteracted by mountain climates than by the warm climates of inland plains or of the seaside, as is shown by the observations of Spengler in Davos, of Denison and Solly in Colorado, of

Theodore Williams and the author himself. No doubt, cases of hæmoptysis do occur at high altitudes, but they are decidedly less frequent than in the plains.

10. *Profuse Night Sweats* are, as a rule, soon removed by the influence of mountain climates, and their presence may therefore, in doubtful cases, decide us in selecting the mountains.

11. Cases of tendency to *Intestinal Catarrh*, loss of appetite, and want of constitutional vigour are most unfavourably influenced by warm and moist climates, and do somewhat better in dry sea climates, while, unless intestinal ulcers are present, they are best suited by mountain climates.

12. Cases of tubercular ulceration of the larynx, i.e. of *Laryngeal Phthisis*, are not adapted for mountain climates; but such cases, if at all advanced, are practically incurable, though relief is given by warm and moist sea climates, and by sea voyages to moderately warm regions, and, in an early stage, even a cure is thus sometimes effected. Mountain climates are not in the least contra-indicated in simple laryngeal catarrh, but good results may also be obtained on the Riviera, particularly at the moderately moist places, such as Pegli and Nervi, and also at Ajaccio, Algiers, and Palermo.

13. Cases of *Stationary and Apyretic Phthisis* may be successfully treated in very different climates, provided pure air is one of the elements of the climate, and the hygienic conditions are satisfactory. The warm and moist climates must be avoided as a rule, on account of their bad effect on digestion and on the constitution in general, whilst mountain climates are contra-indicated only when the destruction of lung tissue has been extensive. Change of climate is mostly advisable: in summer mountain regions at different elevations, according to the state of the lungs and of the heart, may be selected, or cool sea climates; in spring and autumn, intermediary climates, either of the neutral class or in the Lower Alps; in winter, the moderately dry sea climates, sea voyages to moderately warm latitudes, and also warm and dry inland climates, such as Egypt and Nubia. This does not imply that persons with stationary phthisis should make continual changes: the further they are away from the acute stage the more they may think of a permanent residence at a well-selected station, having thus fair

prospects of a cure more or less complete in the course of several years. Under rational hygienic conditions, and attention being paid to diet, favourable results may thus be observed at a variety of places. At the mountain stations of Colorado, in the Peruvian Andes, the Swiss Alps, in Arcachon, on the Riviera, the coast of Spain in Algiers, and Egypt, and on the English coasts, many such convalescents have taken up their residence, with whose cases we are well acquainted, and who may be regarded either as cured, or as advancing towards recovery.

14. *The Prophylactic Treatment of the Phthisical Tendency*, whether due to pronounced heredity or defective build of the thorax, with impaired respiration, and liability to frequent attacks of catarrh, may demand different modes of climatic treatment according to the constitution of each patient. An occasional change of residence is generally beneficial. We have repeatedly seen very good results in cases where the sojourn at cool and bracing seaside places extended over several years; for instance, in children with family predisposition who were educated at one of the English coast stations, care being taken to select well-ventilated houses, to let the children spend much time in the open air, and brace them up as much as possible. This kind of treatment was followed in the case of four children coming from a thoroughly consumptive stock, the father and mother (also of phthisical descent) having died under thirty years of age of phthisis, and two elder children having succumbed to catarrhal pneumonia at 9 and 10 years of age respectively. The result was, that all the four children developed well, and that they are now, at ages between 25 and 30, in the enjoyment of good health. Mountain resorts are also adapted for prophylactic treatment, and the bringing up of children at places like Davos, St. Moritz, Colorado, and Denver is much to be recommended, particularly in cases where the chest is narrow.

In the various forms of scrofula, care must be taken to improve the general nutrition, and to stimulate tissue change. Sea air, protracted residence at the sea, and the bringing up of scrofulous children in schools at the seaside are much to be recommended. Scrofulous subjects endowed with little reactive power should spend the winter at

Scrofula.

warm and the summer at cool coast stations. Sea voyages have also a good effect in suitable cases. Residence at climates of high altitude is likewise recommended by their advocates, and has, no doubt, a good effect, but the sea is more potent, and cold or warm sea baths may in suitable cases aid the effect of the sea air.

Rheumatism and Gout.

Rheumatic and gouty affections are aggravated by cold and dampness, and are often produced by these agents. Warm and dry health resorts in sunny situations, either at the sea, or inland, act beneficially, and have the great advantage of enabling invalids to take outdoor exercise regularly. Gout is, indeed, sometimes aggravated by a sojourn at the sea, particularly if constipation results from it; but this drawback can in most cases easily be remedied by medicines.

Cases of *Heart Disease*, so frequently associated with rheumatic affections, are mostly benefited by suitable climatic treatment. Opportunities for taking walks on level ground are essential. The higher mountains are, with few exceptions, not suitable, whilst in cases of dilatation of the heart with diminished muscular force, climates at a medium elevation of from 1,000 to 2,000 feet, such as Ischl or Aussee, generally do more good than sea climates, where in similar cases disturbance of digestion and of the action of the heart is apt to occur. Egypt, Nubia, Pisa, or Pau, are most suitable for the winter; neutral climates, such as Baden-Baden, Wiesbaden, and the climates of the Lower Alps (Pallanza, Lugano, or Vevey), may be selected for spring and autumn. In cases of arterial disease, particularly in atheroma, mountain climates are contra-indicated, more especially during the cold season, when in Alpine climates apoplectic seizures are apt to occur. If congestion of the lungs and of the liver be produced by heart disease, treatment by medicines is called for.

Cases of *Renal Disease*, if of old standing, are rarely cured by climatic treatment; but, under proper precautions, warm and dry climates, such as Egypt, or the Riviera, generally have a good effect in winter and spring, partly on account of the increase taking place in the action of the skin, and the diminution of the renal secretion, partly also because they facilitate the functions in general. In summer, dry and neutral climates

at a moderate elevation may be selected. Strict attention to the action of the skin and to diet is the principal requirement in all cases, whilst the selection of a suitable climate may, in addition, benefit them much.

Chronic Catarrh of the Bladder, and the urinary organs in general, is frequently much influenced by climatic conditions, and the treatment which has chiefly to be directed to regulation of diet, and to keeping up the action of the skin, is much assisted by the use of moderately dry, warm, and equable climates. In similar affections, if want of proper rest and care seemed to retard recovery, we have seen remarkably good results in 8 cases from long sea voyages of from three to twelve months' duration, results which we were inclined to attribute chiefly to the enforced rest of body and mind.

The *Diseases of the Organs of Digestion* are so multiform that general rules can hardly be laid down for them. In our treatment we have to study the nature of each individual constitution. Regulation of the diet and of exercise, and treatment by medicines, baths, or hydrotherapeutics, must frequently precede the change of climate, and are often sufficient alone; but in very chronic cases, particularly if combined with lowness of spirits, a comparatively long treatment by climate is necessary. Thus persons of torpid constitution are benefited by mountain climates in winter, as well as in summer, making use of intermediary stations in the spring; whilst weakened or aged persons require dry warmth in the winter, mountain stations of medium and low elevations in summer, or, in some cases, bracing sea climates. Voyages, as already known to the ancients, are *per se* important elements in the treatment of affections of the digestive organs, and often make dyspepsia of long standing disappear. The nature of the drinking water, the quantity and quality of the food, and the manner in which this is prepared, must be well considered when a climatic resort is selected for persons suffering from affections of the digestive organs; bodily exercise is likewise of great importance, and must be regulated in each case according to the strength.

Affections of the Nervous System should more often be subjected to treatment by climate than is customary.

In cases of *Mental Depression*, voyages and residence at places of historical interest, and affording social attractions, have often very good results, particularly if there are at the same time facilities for bodily exercise. A winter spent in Rome is, in this respect, frequently attended by striking improvement in the case of those who can appreciate these advantages.

Others benefit by travelling because it keeps the mind occupied, and removes their thoughts from the accustomed narrow spheres. Egypt and the Nile voyage, southern Italy, Sicily, Spain during the cooler seasons, and also mountain tours in summer, according to the amount of strength and the mental condition of the patient, may be most effectual as remedial agents.

Cases of *Hypochondriasis* require similar treatment, which may be assisted by hydrotherapeutic applications, or by sending the patient to some watering-place.

To the same category belong conditions which border on insanity, and which may perhaps be classed under mental disorders. A great deal may often be done in these cases by frequent change of residence and travelling under medical supervision. Mountain climates proper are to be avoided in conditions associated with excitement, whilst indifferent and moderately moist sea climates, with exposure to the sun and a bracing air, have a beneficial effect.

Exhaustion by Overwork, or from severe acute disease, often requires treatment by climate for years, which is sometimes attended by good results, even in very grave cases. In those who with good constitutions become mentally exhausted by the strain of overwork, long residence at mountain climates, with change of abode during the unfavourable times of the year, has a very good effect; for persons, on the other hand, who cannot well resist cold, milder climates and places in the Lower Alps are suitable, and during the cold season resorts on the Gulf of Naples, such as Castellamare and Sorrento, or at the Gulf of Salerno: for instance, Amalfi, or the whole Riviera, Algiers, Sicily, or the coasts of Spain.

Cases of *Neuralgia* require various treatment, according to the constitution of the patient: if they are caused by gout or

rheumatism they are favourably affected by warm and dry inland climates, such as Egypt; whilst at the Riviera neuralgic affections often become aggravated. Some cases of uncomplicated neuralgia are benefited by the somewhat moister and moderately warm places, like Pau or Rome; in others, stations situated in the Lower Alps are indicated, such as Meran or Pallanza, whilst for the summer there are a variety of health resorts which may be recommended, and in particular mountain climates of different elevations, according to the state of the circulatory organs. Where there is a history of malaria, mountain climates are indicated in summer, and dry seaside climates in winter. Uncomplicated neuralgia is sometimes related to psychical disturbance, and must be treated like the same.

This also applies to hysterical cases, which are likewise frequently injured by the climate of the Western Riviera, whilst generally they do well at Pegli and Eastern Riviera, in Pisa, Rome, on the Gulf of Naples, and in Ischia. It is, however, often difficult to predict which climate will benefit these cases.

Cases of *Spasmodic Asthma* are much influenced by climatic conditions, but it can but rarely be predicted in what way the latter will affect this disease; generally speaking, mountain climates do more good than the seashore, whilst on the Western Riviera the asthma is sometimes aggravated, as has been shown by Dr. Frank, under whose notice several such cases came in Cannes. The author attained some good results by sending cases to the Swiss Alps, but no general rule can be laid down from this experience. Hence in these forms of asthma we cannot decide anything until a preliminary trial has been made, and the result is often quite unexpected. Precautions as to diet and hygiene should always be well attended to.

In chronic disease of the *Spinal Cord*, particularly locomotor ataxy, travelling without exertion in dry, sunny, and warm climates, or a sea voyage, may be beneficial, care being taken that the mind is kept well occupied by change and amusements, whilst cold and damp climates must be avoided. The author observed in two cases of ataxy not only temporary arrest of the symptoms, but very considerable and lasting improvement by

change of residence, extending over several years, between Egypt, Algiers, and Palermo in winter, Rome and the Gulf of Naples in spring and autumn, Ischia and Capri in summer, at times also England in summer, and an occasional cruise in a good yacht.

Diabetes or glycosuria may vary much in importance according to the age of the patient, his constitution, and the accompanying symptoms; and the climatic treatment has to be modified in proportion. Dietetic treatment will always be of primary importance, but its influence will be considerably assisted by residence in a sunny, moderately dry, and not too hot climate, change being required according to the seasons. The temperament of the patient requires particular attention in these cases.

For diseases of the *Vasomotor Centres*, such as exophthalmic goître and other similar conditions, extreme climates are unsuitable, and they are most benefited by moderately dry, sunny, and rather equable places, which have a cheering effect without being exciting at the same time. Much time has to be spent in the open air, but fatigue must be avoided. Four cases in the commencing stage of this affection which came under our notice improved very much by a prolonged residence at St. Moritz, Pontresina, the Bel-Alp, the Maderaner Thal, and on the Rigi, the disease making no progress during several years, until anxiety, unrest, mental emotion, and other unfavourable circumstances caused recrudescence and full development of the symptoms. In two further cases the arrest was lasting.

In *Morbid Conditions of the Blood* treatment by medicines, or courses of mineral waters and baths, is mostly required first of all, whilst careful regulation of the diet and attention to hygienic rules are necessary in all cases. Climate, however, will always greatly assist the treatment, and will be the chief agent in some cases where medicines do not agree.

Thus, as regards *Chlorosis*, places are to be recommended where the whole day may be spent in the open air, without demands being made on the bodily strength. In summer, when great heat mostly does harm, mountain climates are often useful, the elevation varying according to the degree of the disease

and the condition of the heart; and there must be shady walks, hammocks, Bath chairs, and other conveniences for enjoying the open air; during the cold season, sunny stations in the Lower Alps, such as Pallanza, Meran, Montreux; or if sea air agrees with the patients, the Riviera or Palermo; even the comparatively cold seaside places are mostly beneficial in summer, as well as in winter. For instance, in summer and the early part of autumn, places on the east and south-west coast of England, such as Folkestone, Eastbourne, Ramsgate, Margate, Lowestoft, Scarborough, &c.; whilst later on in autumn and in winter, Ventnor, Bournemouth, and Brighton are available. If attention is paid to warm clothing, and if a fair quantity of food is taken, a moderate amount of cold does no harm; on the contrary, on clear days it is mostly useful by raising the appetite. In those who are good sailors we have seen great benefit resulting from cruises of some duration in yachts in temperate climates, with occasional stoppages at seaside places. If the anæmia is less pronounced, or if it is diminishing, places with animated social conditions and other resources are often beneficial: for instance, Florence in spring, Rome in winter and spring, Naples in autumn, winter, and spring, Castellamare and Sorrento in spring and autumn, Capri and Ischia during the same seasons.

Cases of *Anæmia* of a different nature call for either the same or a similar treatment according to their causes. In cases of profuse menstruation, sea climates often do harm, whilst subalpine, and frequently even Alpine climates are beneficial; in scanty or deficient menstruation sea climates are most useful.

Leucæmia and *Hodgkin's Disease*, in two cases well observed by the author, seemed to be benefited by long cruises in yachts, with occasional stoppages and a stay in Egypt and Algiers. In advanced cases little is to be expected.

If *Malaria* be the cause of the anæmia and organic disease, malarious districts must, of course, be avoided, and Alpine or subalpine climates are to be recommended for the greater part of the year, whilst during several months moderately warm and dry sea climates may successfully be resorted to.

In the general debility which follows acute disease, that is, in *protracted* and *incomplete convalescence*, the treatment

must differ according to the nature of the preceding disease and the constitution of the patient, and also according to the degree of debility. The fact must never be lost sight of, that the liability to disorders of different nature is much increased in convalescents from severe acute diseases, especially fevers, whilst the power of resisting external influences and the muscular activity are at a low standard. It is therefore advisable in such cases to begin with country places within easy reach, where comfortable quarters are procurable, whether they be situated in hilly or wooded districts, or at the sea, and to move to more distant places later on. In convalescence after whooping cough and diphtheria sea climates are to be preferred, whilst after scarlet fever and typhoid, moderately warm and sunny resorts, either inland or at the sea, are indicated. Though in many cases improvement may not be quick—for instance after severe typhoid—we must not despair. When Peter Frank said that typhoid fever took three months out of one's life, he gave only the average duration; for sometimes, and especially if the attack has occurred at an advanced age, years may elapse before the former strength and elasticity will be restored to any great extent, though patience will nearly always be rewarded at last.

The *Climacteric Conditions*, in the widest sense of the term, are also important objects for treatment by climate. It seems to us that the word 'climacteric' should have a more extensive application than is usually given to it. The general public are quite ready to attribute to 'change of life' all disturbances occurring in women between the ages of forty and fifty-five years, but the period of puberty is almost quite as often surrounded by dangers as the period of cessation of the sexual functions, not alone in women but also in men. In both sexes, the quick rise to a higher stage of development, as well as the rapid descent to a lower stage, are sometimes attended by a variety of disorders either of the nervous system, or the organs of circulation, or the functions of digestion and assimilation. The cessation of the sexual functions and also their first development are but the most striking symptoms of the climacteric periods; other important functions undergo similar changes, and the harmony of the whole organism is

sometimes violently disturbed, whilst in other, and fortunately in most of the cases, these processes take place in a much milder manner. Change of climate *per se*, voyages, with the diversion they give to the mind, invigorating subalpine and maritime climates for the summer, and comparatively dry and sunny resorts for winter, are to be recommended, and assist the restoration of the equilibrium and the adaptation of the altered functions to the system at large. The ordinary health resorts are not necessary in these cases, but places like Rome, the Gulf of Naples, Sicily, Spain, Palestine, and Greece often deserve the preference, due regard being paid to general rules and to the condition of the patient as to body and mind. Related to these are conditions of *delayed development*, in which either the seaside or Alpine and subalpine climates have a good effect.

Senility, whether of premature occurrence or not, and the accompanying changes in the various organs and functions, are in many ways benefited by change of climate. Premature senility of different organs is of frequent occurrence, being sometimes mistaken for ordinary disease, and uselessly treated by medicines. Lowering of the general activity and the power of resisting external influences are the principal symptoms; the quantity of food and of stimulants which was formerly well borne causes disturbance; the amount of bodily or mental work which formerly stimulated the energies produces fatigue; and the low temperatures or meteorological changes, which formerly raised the appetite, and caused increased desire for bodily exercise, produce so called 'colds,' manifesting themselves as catarrh, bronchitis, or rheumatism. As the body does not possess sufficient reactive power, bad effects are produced by low temperatures, increased humidity of the air, cold winds, and sudden changes. By resorting to warm, sunny, and dry climates during the cold seasons, like Cannes, Nice, Mentone, San Remo, Pegli, Algiers, or Palermo, or stations in the Lower Alps, such as Pallanza, Lugano, Meran, or Montreux, the demands made on the system at large are diminished, many complaints arising in cold climates are avoided, and in this way not only can old age be made more agreeable, but even life may be prolonged. In addition to the cold climates, the climates of the High Alps

sometimes produce disagreeable symptoms in old persons, and are therefore to be avoided, whilst lower elevations up to 3,000 or 4,000 feet generally do good in summer. In treating old persons, the fact must not be lost sight of that in them all functions, both of the mind and of the body, have a tendency to become torpid unless they are kept in constant exercise, so that it is necessary to keep the faculties in action by stimulating body and mind. For this reason voyages are indicated, and residence at places where the mind is stimulated by social intercourse, art treasures, and other resources, and where at the same time facilities for bodily exercise are offered; thus, according to the season and the peculiarities of the constitution, Naples, Rome, Florence, Venice, and also other places possessing art treasures, such as Dresden, Munich, Paris, Berlin, or London, are available. Change *per se* frequently does good; thus in England excellent results are seen from visits paid by aged Londoners to places like Brighton or Folkestone, and on the other hand, from temporary residence in London in the case of the inhabitants of the provinces.

IV.

HOME CLIMATIC TREATMENT.

In the preceding section we have neither exhausted the subject of the climatic health resorts, nor of the cases which may be benefited by suitable climatic conditions. There are, indeed, but few diseases in which benefit may not be derived from due regard being paid to the conditions of the air, and we all, knowingly or unknowingly, practise climatic treatment in the bedroom, the sick-chamber, and the house; and more depends, as a rule, on their due observance in health and disease than on treatment by medicines. On observing the good results attained at climatic health resorts in the case of invalids, and on examining the particular influences to which these results are due, the following conclusions will be arrived at:

1. That in many cases, by making proper use of the opportunities given at the patient's home, quite as much may be achieved as by residence at a distant health resort.

2. That by making certain alterations in the patient's habitation, and in his mode of life, the climatic conditions of his home may be considerably improved.

3. That by erecting well-arranged establishments, under medical supervision, in well-situated places near at hand, a great many of the advantages of more distant climatic health resorts might be gained.

As many invalids are unable, partly on account of the cost, partly for other reasons, to migrate to distant health resorts, attention to these points is of great importance. Many physicians besides the author have been struck by this fact, and we would only point to the writings of the elder MacCormac,

who considered impurity of the air as the chief source of phthisis, also to those of P. Niemeyer, of Rohden, and others; whilst Pettenkofer must be mentioned for the valuable rules he has laid down on clothing and the arrangement of rooms and houses.

Although it is not an easy matter for those who are in their ordinary routine of life and engaged in business to devote the most suitable hours of the day to necessary outdoor exercise, and to take their meals with proper leisure—still this task becomes much easier when its importance has once been recognised, and a habit gradually springs up of living according to dietetic and hygienic rules, which fortunately in many cases suffices to restore health.

Cases must have frequently come under the notice of every physician, in which, though a change of climate was impossible, scarcely-hoped-for improvement was effected by the patient altering his occupation or his mode of living. For instance, we have seen bakers who had become consumptive whilst they were in the bakehouse or in the shop gradually regain their health by daily wheeling the bread-barrows through the streets for three or four hours and in any weather; and other trades and occupations have furnished us with similar instances. Getting used to the open air is sometimes difficult, and requires much circumspection in unfavourable climates, but this training can be accomplished in many cases, and must frequently be pushed with some boldness. Bad results do undoubtedly occur, as from almost every method of treatment, but the final result will in the long run be favourable. It is not always easy to get the patient accustomed to daily repeated frictions, whether applied with the moist or dry towel, or cold or warm, and other hydrotherapeutic applications may also be disliked at first, but with care and patience final success is mostly attained. By observing the ordinary hygienic measures which are more or less accessible to everyone, such as daily exercise in the open air, proper ventilation of rooms, and simple hydrotherapeutic applications, more can often be attained than distant climates can offer.

Results better even than in most private houses may be obtained in well-arranged establishments possessing large

rooms, well ventilated, with plenty of sunshine, and with open verandahs; care being taken that the meals are regulated by the resident physician, and that exercise, gymnastics, and hydro-therapeutics are properly employed. Many of the results obtained in Görbersdorf, Falkenstein, and also in Davos are not due to the climates of these places, but to the systematic regulation of the whole life of the invalids, and the same holds good for the sanatoria on the coasts of England, such as Ventnor, Bournemouth, and Torquay. The creation of a greater number of such establishments would supply a public need. Experience will in time lead to a further improvement of these establishments, and what is gained here will find its way into family circles. It is, however, indispensable that the arrangements in these establishments should be in accordance with hygienic requirements, so that overcrowding and consequent sources of infection may be avoided.

In every kind of chronic disease, the physician has to examine accurately the results attained by change of climate, and trace them to their causes, so that he may be able to profit by the experience gained, and by necessary alterations to make home and its surroundings assist in the cure.

GENERAL BALNEOTHERAPEUTICS.

BY

DR. OTTO LEICHTENSTERN.

TRANSLATED FROM THE GERMAN

BY

JOHN MACPHERSON, M.D.

INSPECTOR-GENERAL OF HOSPITALS (RETIRED).

INTRODUCTION AND DIVISION.

When I undertook to furnish the chapter on Balneotherapy in the present 'Handbook of General Therapeutics,' although I was to a certain degree encouraged to the undertaking, by my having previously lectured on the subject, yet I was not blind to the difficulty of accomplishing my purpose. There was no foundation but a clinical one for solving my problem. It was required to set forth the general therapeutic value of the most important mineral waters employed for drinking or bathing, and also that of thermal waters and of sea bathing; to examine their mode of operation, and to condense into a kernel, what experience has taught respecting the use of those agents in sickness.

Balneotherapy, or the 'science of the therapeutic application of mineral waters,' or, as it is commonly defined, 'the science of the method and mode of operation of bath and well cures' (the name, indeed, makes use of the license of taking a part for the whole), is marked by the great variety and the great differences of its curative agencies. The very different application of water, for drinking or for bathing purposes, at once divides the subject into two parts, which are fundamentally separate. Of their real co-operation with each other we could only speak, so long as the absorption of the salts dissolved in the water was believed in. Besides this, we have the difference of chemical composition and of pharmaco-dynamic character of different mineral sources, some of which, as the indifferent thermal waters, contain nothing besides water in quantity worth mentioning, while others are more or less rich

in salts and gases. If we add to this the complicated and composite nature of the bath and waters cures, which have become so inordinately popular, in which the importance of bathing and of drinking is often materially outweighed by the dietetic, hygienic, climatic, and psychical factors bound up with them, it is abundantly plain, what a variety of agencies we have to deal with in balneotherapy.

The curative agents in balneotherapy are therefore—

1. The hydrotherapeutic, inasmuch as we have to treat of the operation of cold baths (sea bathing), of warm and hot water baths, of vapour baths, of douches, of cold frictions, and the other processes of hydropathy, while at the same time the water swallowed in many drinking cures, often plays an important part.

2. Pharmaco-dynamic, inasmuch as in drinking cures with solutions of salts or of gases, these constituents accomplish certain operations in the system. Under this head also comes the absorption of gases, which are eventually absorbed by inhalation, by the use of dry gas baths, and by that of baths of waters rich in gas.

3. Hygienic (climatic and dietetic) and psychical, inasmuch as a judiciously changed mode of life and diet, removal from injuriously working home influences, the rest and freedom from professional work, the residence in a new neighbourhood and different climate, in forest, mountain, or sea air, and the increased amount of exercise taken, very often, according to common experience, effect a favourable change in the system, both corporeal and mental, in the spirits, in the appetite and digestion, as well as have a direct or indirect favourable influence on particular pathological conditions.

Undoubtedly in many instances all these three factors cooperate in nearly equal degree in producing favourable results. In other cases the pharmaco-dynamic character of the well, the abundant consumption of water, the cold or warm bath in connection with the different processes of hydropathy, may be the most potent agents, possibly also now and then the skin-stimulating effect of the salt or gas constituents of the bath.

It is hard to determine to which of these influences the lion's share is to be assigned in a particular case, seeing how

complex is the character of drinking and of bathing cures. In any case no one will pretend to deny that numberless cures are to be set down not to bathing and drinking, but to the various hygienic, dietetic, and psychical changes which have just been enumerated. We are taught that it is so by daily experience and by rational consideration of the question. One and the same well is recommended for the most different ailments, and springs of the most different chemical characters, or simple climatic cures, are efficient in relieving the same pathological conditions.

It is plain that there is nothing specific in the three factors which we have enumerated, which can make their efficacy be confined to particular spots. Wherever warm and cold baths, hot and steam baths, douches and cold frictions, and baths containing salts are used as remedial agents by medical men, and properly and methodically applied, the same curative results are obtained as at baths. The use of certain natural or of equally good artificial waters is widely spread among practitioners, and there are neither facts nor reasonable grounds for believing that a mineral water, used systematically at home, is less efficacious than when drunk at the well under the eye of the bath physician. As for the hygienic elements of the third factor, they are very much the same points as are attended to by every careful physician in his ordinary practice, and with the best effect. The regulation of the hygienic relations of the patient with reference to air, dwelling, nourishment, clothing, mode of life, exercise in the open air, avoiding injurious influences and bad habits, the forbidding of mental or corporeal over-exertion, &c., are measures which we prescribe, without waiting to send patients to baths or health resorts, and are measures which we regard as of much importance in the treatment of chronic disease. If, nevertheless, occasionally a chronic case of disease, which has resisted all remedial treatment at home, first begins to mend by the use of a bathing or drinking cure, this change is not solely owing to the change of hygienic conditions, but because the patient, when he has arrived at a bath, has not only time and inclination, but is to a certain degree compelled to carry out those changes in his mode of living, which in the press of business and of employment at home he

neglected to make. It is very plain that in all cases where methodical use of baths and waters, along with exercise in the open air, cannot be carried out, owing to the occupations of patients, the only way remaining is to send them to a bath.

The threefold division given above of the factors of a bath cure, furnishes the best division for a general balneotherapy. But I find that I cannot adhere to it, because two of those factors, hydropathy and climate, are specially treated of in other parts of this work. In the first of them the physiologico-therapeutic effects of the cold and the warm bath, of vapour baths, of local baths, of local and general warm and cold douches, of cold frictions and packings, and other similar processes, are exhaustively described. In the climatotherapy will be found all our general knowledge respecting the operation of different climates, increased exercise in the open air, and complete change of mode of life. Both of these parts, therefore, discuss questions having much importance in bath therapeutics.

The sphere of my discussion is further limited by my not intending to enter into a minute description of individual baths, with their prescribed routine, sometimes bordering on charlatanism, sometimes ascribing exaggerated importance to particular rules as to bathing and drinking, with their over-special regulations about diet, lodging, and mode of life of the patient. I avoid also questions as to the proper season and proper duration of bath cures; and as to special indications and contra-indications of individual baths in certain forms of disease, questions which are treated, if not with much scientific method, at least at abundant length in treatises on therapeutics. They are found discussed at still greater length, and with a show of scientific phrases, in books of special balneotherapy, and in the separate descriptions of individual baths.

I confine myself, therefore, to describing the therapeutic effect of the baths and waters employed in balneotherapy in the widest sense of that word. In this I shall not merely consider the empirical facts of this branch of therapeutics, but shall attempt to explain, according to the present state of therapeutics, the mode of operation of these agents.

I shall therefore describe in the

First Part, the physiological and therapeutic action in general

of the simple and the salt or gas containing baths employed in balneotherapeutics. In the

Second Part, the physiological and therapeutic action of increased water drinking. In the

Third Part, the physiological and therapeutic action of the most important groups of mineral waters, and their empirical or rational use in certain forms of disease, with reference to the pharmaco-dynamics of their mineral constituents.

To this I shall add tables of the most important wells, and of their predominating constituents, calculated for the general wants of practitioners.

Before entering on my present theme I should like to offer a few observations on the present condition of balneotherapy, and of its relation to general therapeutics.

The advances made in medical therapeutics within the last decennial period, apart from some brilliant discoveries, are chiefly in the changed methods of regarding the subject. In place of the former facility of belief, which looked on all favourable results in the light of *post hoc ergo propter hoc*, and thoughtlessly accepted the dicta of authorities, an objective critical mode of judging of the effects of therapeutic actions has been introduced, hand in hand with accurate clinical observation. The conviction has been forced on us more and more, that the tracing of the effects of articles of the materia medica is one of the most difficult problems, inasmuch as the effect may often be produced by various unknown factors, the operation of which may have been quite independent of the therapentic measures applied.

The enthusiasm, often springing from humanitarian or selfish views, with which, even at the present day, new remedies are praised up, and old ones recommended in a new fashion, is no longer dangerous. With the present mode of observation at the bedside, there is no danger that important discoveries will be overlooked or laid aside, or that useless recommendations will receive undeserved notice.

The science of modern therapeutics is unceasingly engaged in endeavouring to bring into useful application the facts of physiology and of the ætiology of disease, and is struggling to resolve into its elements, the operation of empirical articles of the materia medica whose use is recognised, and to arrive at a knowlege of their mode of action. When it does not succeed in this, it does not on that account make light of empirical remedies. It would mistake its position, and would merely show its poverty in the power of observation, if it were

only to recognise the virtues of those remedies concerning which physiological experiment has arrived at some positive conclusions. This is not the place to explain, how with the progress of medicine the points of therapeutics to be investigated have altered, how its problems and the means of solving them, and even the limits of therapeutic knowledge, have come out more clearly, the latter being partly narrowed and partly expanded.

Along with pathological anatomy and the ætiology of disease, physiology has had very great influence on therapeutics. While it is occupied in discovering and explaining the normal functions of organs as regards themselves, and in their interchange of relations, the facts and laws discovered by it are laying the most important foundation for medicine. Its teachings accompany our thoughts at the bedside, determine and regulate our therapeutic treatment; the adoption of its methods of experimental research by pathology and by therapeutics has opened a new path for both of them. The materia medica of to-day has obtained a new and very promising starting-point by the introduction of physiological and chiefly of experimental methods, and has, during the short period of their activity, very decidedly advanced our knowledge of the physiological action of articles of the materia medica, and of various therapeutic proceedings in different directions.

If we ask the question whether that backward branch of the subject, balneotherapy, has taken any part in this progress of the more accurate method of therapeutics, we must give a doubtful answer. A survey of the present condition of this therapeutic speciality shows us several steps towards improvement. Instead of the former charlatanist treatment at many baths, where many bath visitors and real invalids also merely imitated instinctively what they saw others do, careful medical examination and observation of the patient has been introduced, and the study of the individual case has become usual. The spring alone is no longer considered to be, in its very various applications, the sole curative agent; the same attention and care as about bathing and drinking, is now applied to prescribing the appropriate diet and mode of life of the patient and everything belonging to it. Medical and surgical treatment are not neglected. I would merely allude to the local treatment of laryngitis, of uterine and of skin diseases, to mercurial and iodine cures, to inhalations and pneumatic therapeutics, to the surgical treatment of ankylosis, wounds, &c., to the processes of shampooing, and to many others. Little doubtful though it is, that the carrying out of medical or surgical treatment, along with the use of drinking or bathing, is in many cases of the greatest importance, and although it is a matter for congratulation that excellent specialists have begun to settle at baths,

nevertheless there are very palpable evils in this direction. Only to cite one example; if a woman, after months' long special gynæcological treatment, is sent to a bath for refreshment and for the improvement of a lowered state of nutrition, and also with the hope of possibly effecting the resolution or absorption of exudations—if such a patient falls into the hands of a specialist, and is treated afresh with new digital, specular, and sound examinations, with varied methods of dilatation of the cervix, with scarifications, intra-uterine injections, pessaries, and the like, one need not wonder, if such a victim to gynæcological over-zeal does not derive the benefit she had expected from the use of baths, and returns home worse than when she set out. Similar examples might be quoted from some of the sulphur wells, where unnecessarily active treatment by mercurial cures is carried on, ignoring former treatment, as well as excessive local treatment of throat catarrhs, ulcers of the larynx, and other. I do not speak from hearsay, but from frequent personal observation.

Important advances have been made in bath technique or appliances. Use has been made of the proceedings of its sister, hydrotherapy; wave and vapour baths, different forms of douches, of rubbing, and of packing have been introduced, as also the modern methods of inhalation and of pneumatic treatment.

The theoretical views of the operation of mineral waters have undergone a marked change since former days.

The potency of heathen or of Christian well spirits, to whose secret operation the wonderful healing action of the waters used to be attributed, is a belief now quite of the past, although reminiscences of it survive in these days of enlightenment in the discovery of the 'supernatural' waters of Lourdes and Marpingen. The spirit of speculation in puffing wells, though veiling itself in scientific-sounding phrases, is dying out, although it still occasionally shows signs of its existence.

When in these days it is proposed to analyse the operating factors of a mineral spring in its inward or outward application, enquiries are only made as to its temperature and its amount of salt or of gas, as to the pharmaco-dynamical action of the salts and gases contained in the water, and as to the operation of large amounts of drinking water, and similar points. Every newly discovered spring, which makes any pretension to be admitted into the circle of acknowledged waters, has, as the easiest mode of attaining that object, at least to furnish a physico-chemical analysis of its character and constituents.

Since balneotherapy, following the example of other branches of practical medicine, assigns due weight to the facts of physiology and of pharmaco-dynamics which come within its province, since individual

investigators have successfully solved by the way of experiment some of the more important questions in balneotherapy, since it has been admitted, even by bath specialists, that various bathing and drinking cures owe less to the baths and the drinking than to hygienic, dietetic, and psychical factors, opinion concerning the healing virtue of waters has freed itself from the former incubus of the wonderful and the mystical; the belief in the specific action of baths in particular diseases is completely shattered, and the conclusions and explanations afforded by balneology, bear much more of the philosophical stamp.

The results at which various investigators have arrived in their researches into the physiological and pharmaco-dynamic action of certain constituents of waters, into the operation of cold, warm, and hot baths, of the salt and gas containing and therefore skin-stimulating bath, on the temperature of the body, on its parting with heat, on the regulation of the temperature, on the excretion of carbonic acid and of nitrogen, on the respiration, the circulation, &c., are, apart from the great advance of the chemistry of mineral waters, laying new foundations; on these again we must work with zeal, if balneotherapy is to emancipate itself from its present empirical stage and thus become a scientific branch of the tree of exact therapeutics, i.e. therapeutics that can explain the effects it produces.

The progress in balneology just described, which is founded mainly on a more accurate observation of the patient and on the experimental study, after the physiological method, of the operations of water, of salts, and of gases, has given modern balneology a quite altered appearance, and has greatly contributed to increase its scientific consideration. Nevertheless it is evident that the possession of a few physiological facts does not necessarily imply a physiological mode of thought, if we turn to modern manuals of balneotherapy, and observe the misuse in them of the simplest physiological facts. Our still scanty knowledge of the physiological action of warm and cold, of salt and gas containing baths, and of the physiologico-pharmaco-dynamic action of the individual constituents of the water, is carried into the domain of pathology far beyond the boundary of certain conclusions, and to the construction of what are often only haphazard theories. We shall in the sequel, in the examination of individual groups of waters, frequently have opportunity to criticise those extravagances, which have been spread abroad under the spurious names of 'scientific' or of 'physiological exactness.'

The phrases which used to flourish like rank weeds in the older balneology, such as the 'blood-purifying power' of certain waters, 'active vivification,' 'increase of or aid to metamorphosis of tissue,'

'beneficent alteration of exciting or depressing action on the nervous system,' 'revivification of the mass of the blood,' 'increase of cell activity,' 'blood moulting,' 'increased activity of the blood life in the sense of progressive or of retrogressive metamorphosis,' these and numberless equally bad or worse fashions of speech have still a place in modern works on balneology, which boast freely of their physiological accuracy. If one endeavours to ascertain the origin and meaning of those and of many other phrases which are difficult to eradicate, we find that they are nothing more than unscientific circumlocutions, which express the simplest facts of experience (for instance, better nutrition, increase of weight, &c.), or they are unlucky or mistaken deductions from perhaps ingenious but very generally imperfectly ascertained results of physiological research. Even that problem of distant solution in all branches of natural science, the attempt to solve all phenomena in one complicated sum of molecular and atomic motions, has lately found an advocate in balneology. The balneology of molecules and of the future, inaugurated by him, raises itself in a proud Icarus flight away over the workshops of inductive investigation. With the help of a few frequently misunderstood ideas, borrowed from molecular physics, he talks of 'spectrum of heat,' of 'heat colours and tones,' of 'concert of heat,' and absolutely of a 'special kind of heat,' of thermal waters, and the like. I have preserved for myself a selection of the flowers of this modern style, in case by chance it might be required, if there should be a reply to my criticism. It were greatly to be desired, that with the changed method of observing and enquiring in balneological subjects, their literature would finally abandon the *feuilleton* style and employ the less flowing speech of science.

After a careful examination of what we know in a theoretical point of view of the mode of operation of drinking and of bathing cures, of the physiological effects of the cold and the warm bath, of baths containing salts and gases, of abundant water-drinking, and of the swallowing of particular mineral waters, we arrive at the conclusion that, in spite of many important labours in this field, our present knowledge does not suffice to build up on it a satisfactory theory or explanation of the mode of operation of mineral waters in different pathological conditions. The present position of balneotherapy is empirical, and is founded on the observation and experience of physicians. The fact, that different bathing and drinking cures are found to be efficacious in various chronic affections, that the curative agencies of balneotherapy belong to the most important and most indispensable in therapeutics, cannot be impugned by any criticism.

A general balneotherapy, in the same sense as there are, a general

physics, or a general chemistry, (which, gathering together the results of numerous individual researches, develope the general laws which dominate the phenomena in the whole of these branches of science), has no more an existence, than in this point of view general therapeutics has. General balneotherapy has to extract the factor of our practical experiences from the therapeutic action of mineral waters, as far as our knowledge of the operation of the most important agents in water cures has developed itself.

FIRST PART.

THE PHYSIOLOGICAL AND THERAPEUTIC ACTION IN GENERAL, OF THE SIMPLE, OR OF THE SALTS OR GAS CONTAINING BATHS, THAT ARE USED IN BALNEOTHERAPY.

THE simple and the mineral water baths, which are employed in balneotherapy, can produce physiological and therapeutic effects, by their direct and indirect influence on vital processes. The study and the analysis of those actions is one of the most important scientific problems of modern balneology. The causal foundation and explanation of the curative effects of mineral baths, which partly rests on empirical grounds, depends on the results of this examination, which works with the aid and methods of physics, of chemistry, and of physiology. Small and modest are these beginnings, but they almost vanish out of sight, in contemplation of the enormous problems which the physiological analysis of so complicated and many-sided a subject, as that of mineral baths in disease, has still to solve. Various actions, partially co-operating with each other, are evoked—

1. By the temperature of the baths (thermal effects);
2. By their mass (pressure and mechanical effect);
3. By the salts and gases which are in solution in the baths.

Correct though this division be, we, for the sake of brevity and to avoid repetitions, prefer another one. We always add to the consideration of the action of baths of different temperatures on the retention of heat, the change of tissue, the circulation, the respiration, the nervous system, and so on, the question, whether the thermal effects produced sustain any, and if so what, modification from the simultaneous presence of salts

and gases in the water. Such a division has certainly this recommendation, that beyond question, of all the effects of baths, those which are to be ascribed to the water—that is, to its temperature—are more important than all the others, and that without a knowledge of this powerful factor, it is impossible to enter on the study of the possibly specific influence of salts and gas containing baths.

As the account of the physiological and therapeutic action of cold, warm, and hot baths, and of all the processes of the water cure, is to be found in the division of this work which treats on Hydrotherapy, we must here confine ourselves to adducing the most important facts, referring my readers to the chapter on Hydrotherapy for details of the investigations and the literature of this subject.

To avoid repetitions I have grouped together in the following list the works which have reference to Chapters I.–IV. of the First Part:—

Braconnot: *Rev. Méd.*, 1833.—Gehler: *Physik. Wörterb.*, vol. x. 1841.—J. v. Liebig: 'D. org. Chem. in ihrer Anwend. auf Physiol.,' 1842. —Walter: *Zeitschr. f. rat. Med.*, vii. 1848.—Krause: Art. 'Haut' in *Wagner's Handwörterb. d. Physiolog.*, ii.—Gerlach: 'Ueber d. Hautathmen,' *Müller's Arch.*, 1851, vol. v.—Johnson: 'Researches on the Operation of Cold Water, &c.' Translated into German by Scharlau, 1852.—Petri: 'Wissensch. Begründ. d. Wasserkur,' 1853.—Homolle: *Gaz. des Hôp.*, 1853.—H. Nasse: *Arch. d. Ver. f. gem. Arb.*, ii.—Alfter: *Deutsch. Klin.*, 1853.—L. Lehmann: 'Ueber d. Wirk. kalter Sitzbäder,' *Arch. f. wissensch. Heilk.*, 1854.—Id.: *Arch. d. Ver. f. gemeins. Arb.*, vol. i. part iv.—Id.: 'Moleschott's Unters.,' vi. 1859.—Id.: '40 Badetage,' *Virch. Arch.*, vol. xlviii. 1873.—Böcker: 'Ueber d. Wirk. v. Sitzbädern u.s.w.,' *Moleschott's Unters.*, vol. vi. 1859.—Berthold and Seiche: *Jahrb. d. Thermalquellen v. Teplitz-Schönau*, 1856, v.—Wundt: 'Ueb. d. Einfl. hydrotherap. Einwickl. auf d. Stoffwechsel,' *Arch. d. Ver. f. gemeins. Arb.*, iii. 1856.—Neubauer and Genth: *Ibid.* iii. 1856.—F. Hoppe: 'Ueber d. Einfl. d. Wärmeverlustes auf die Eigentemperat. warmblüt. Thiere,' *Virch. Arch.*, 11, 1857.—Jones and Dickinson: *Journ. Physiol.*, 1858, Jan.—Mosler: 'Ueb. d. Wirk. langdauernder Vollbäder von erhöht. Temp.,' *Virch. Arch.*, 14, 1859.—Liebermeister: 'D. Regul. d. Wärmebild. bei d. Thier. von constant. Temp.,' *Deutsch. Klin.*, 1859, No. 40.—Id.: 'Phys. Unters. üb. d. quantit. Veränder. d. Wärmeproduct.,' *Reichert's u. Du Bois Reymond's Arch.*, 1860 and 1861.—Id.: 'Aus d. med. Klin. in Basel.' Leipz. 1868.—Id.: 'Unters. üb. d. quantit. Veränder. d. Kohlensäureproduction b. Menschen,' *Deutsch. Arch. f. klin. Med.*, vols. vii. viii. ix. and x.—Id.: 'Ueb. Anwend. d. Diaphorese bei chron. Morb. Brightii,' *Prager Vierteljahrschr.*, vol. lxxii.—Id. and

Gildemeister: 'Ueb. d. Kohlensäureproduct. bei Anwend. v. kalt. Bäd. u.s.w.' Bâle, 1870. Compare *Virch. Arch.*, vol. lii.—Id.: 'Path. u. Therap. d. Fiebers.' Leipz. 1875.—Scharling: *Liebig's Annal.*, vol. xlv. —Beneke: 'Ueb. Nauheim's Soolthermen,' 1859.—Speck: 'Vers. über d. Wirk. mässig kalter Sturzbäder,' *Arch. d. Ver. gemeins. Arb.*, vol. v. 1861.—Id.: *Schrift. d. Gesellsch. z. Beförder. d. ges. Naturwissensch.*, Marburg, 1871,' vol. x.—Kirejeff: 'Ueb. Wirk. kalt. u. warm. Sitzbäder,' *Virch. Arch.*, 22, 1861.—Schiff: *Compt. Rend.*, i. 1861.—Richter: 'Das Wasserbuch u.s.w.' Berl. 1856.—Weyrich: 'D. unmerkl. Wasserausscheid d. menschl. Haut.' Leipz. 1862.—O. Naumann: 'Unters. üb. d. physiol. Wirk. d. Hautreizmittel; ferner über d. Epispastica als excitirend. u. deprimirend. Mittel . . . .' *Prag. Vierteljahrschr.*, 1863, vol. i. 1867, i., and in *Pflüger's Arch.*, vol. v.—V. Bezold: 'Unters. üb. d. Innerv. d. Herzens,' 1863.—Niebergall: 'Ueb. d. Einfl. d. Bäder auf d. Puls u.s.w.,' *Arch. f. Balneol*, ii. 1863.—Merbach: Ibid. ii. 2, 1863.—Kernig: 'Exper. Beitr. z. Kenntniss d. Wärmeregulir. b. Menschen.' Dorpat, 1864 —Bartels: 'Pathol. Unters.,' *Greifswald. med. Beitr.*, 1864, vol. iii. 1.—Schuster: 'Ueb. d. Körpertemp. beim Gebr. verschieden. warm. Bäder,' *Deutsch. Klin.*, 1864.—Id.: 'Ueb. d. Verhalt. d. Körperwärme in d. Aachener Bädern,' *Virch. Arch.*, 43, 1868.—L. Ditterich: *Bayr. ärztl. Intell.-Blatt*, 1865.—Winternitz: 'Beitr. z. ration. Begründ. einiger hydrotherap. Proced.,' *Med. Jahrb. d. k. k. Gesellsch. d. Aertze in Wien*, 1865.—Id.: 'Beitr. z. Lehre von d. Wärmeregul.,' *Virch. Arch.*, vol. lvi. 1871.—Id.: 'Ueb. d. Bedeut. d. Hautfunct. f. Körpertemp. u. Wärmereg.,' *Jahrb. d. k. k. Gesellsch. d. Aerzte in Wien*, 1875.—Id.: 'D. Hydrotherap. auf physiol. Grundl.' Vienna, 1877–80.—Tscheschichin: 'Z. Lehre v. d. thier. Wärme,' *Reichert's u. Du Bois Reymond's Arch.*, 1866.—Id.: *Deutsch. Arch. f. klin. Med*, 1867. —Lovén: 'Ueber Erweit. v. Arterien in Folge einer Nervenerregung,' *Ber. d. sächs. Gesellsch. d. Wissensch.*, 1866.—Cyon and Ludwig: 'D. Reflex eines der sensibl. Nerv. d. Herz. auf d. motor. der Blutgef.,' ibid. 1866.—Tyndall: 'Heat a Form of Motion.' Translated by Helmholtz. Brunswick, 1867.—Sanders-Ezn: *Ber. d. k. sächs. Gesellsch. d. Wissensch.*, 1867. —Ackermann: 'D. Wärmereg. im höheren thier. Organis.,' *Deutsch. Arch. f. klin. Med.*, 1867, ii.—Flechsig: 'Wirkungsw. lauer, aus CO_2 reichen Eisenwasser bereit. Bäd. auf d. Stoffwechsel . . . .' Original paper in *Schmidt's Jahrb.*, 1867.—Jürgensen: 'Z. Lehre v. d. Behandl. fieberh. Krankh. mittels d. kalt. Wass.,' *Deutsch. Arch. f. klin. Med.*, 1867, iii. and iv.—Id.: 'D. Körperwärme d. gesund. Menschen.' Leipz. 1873.—Wunderlich: 'D. Verh. d. Eigenwärme in Krank.' 2nd edit.—Weissflog: 'Unters. üb. d. Wirk. d. Sitzbäder u.s.w.,' *Deutsch. Arch. f. klin. Med.*, 1867, ii.—Lersch: 'D. phys. u. therap. Fundamente d. prakt. Balneol.' Bonn, 1868.—Naunyn and Quincke: 'Ueb. d. Einfl. d. Centralnervensyst. auf die Wärmebild.,' *Reichert's u. Du Bois Reymond's Arch.*, 1869.—Naunyn: 'Ueb. d. Verh. d. Harnstoffausscheid. beim Fieber,' *Berl. klin. Wochenschr.*, 1869, No. 4.—Röver: 'Unters d. Nerveneinfl. auf Erweit. u. Verenger. d. Blutgef.' Gekrönte Preisschr. Rostock, 1869.—Rembold: 'Calorimetr. Unters. an Krank. u. Gesund.' Innsbruck, 1869.—Falk: 'Ueb. eine eigenth. Bezieh. d. Haut-

nerv. z. Athmung,' *Reichert's u. Du Bois Reymond's Arch.*, 1869.—Heidenhain: 'Ueb. Einwirk. d. Nervensyst. auf d. Körpertemp. u. d. Kreislauf,' *Pflüger's Arch.*, vol. iii. 1870.—Id.: 'Beob. üb. d. Einfl. d. vasomot. Nervensyst. auf d. Kreisl. u. die Körpertemp.,' ibid. vol. v. 1872.—Id.: 'D. Einwirk. sensibl. Reize auf d. Blutdruck,' *Pflüger's Arch.*, vol. viii.—Bruck and Günther: 'Vers. üb. d. Einfl. d. Verletz. gew. Hirnth. auf d. Temperat. d. Thierkörp.,' *Pflüger's Arch.*, iii. 1870.—Jakob: 'Grundz. d. Balneotherap.,' 1870.—Id.: 'Unters. über d. Wärmequant. welche im Süsswasser, Kochsalzw. u. kohlensäurehalt. Wasser abgegeb. werd.,' *Virch. Arch.*, vol. lxii. 1875.—Kratschmer: *Sitzungsber. d. Wien. Akad.*, vol. lxii. 1870.—V. Basch and Dietl: 'Unters. üb. d. physiol. Wirk. kohlensäurehalt. Bäder,' *Oesterr. Med. Jahrb.*, 1870.—Röhrig: 'Unters. üb. d. Einfl. v. Hautreizen auf Circulat. u.s.w.,' *Deutsch. Klin.*, 1873.—Id.: 'Physiolog. d. Haut. Berlin, 1876.—Röhrig and Zuntz: 'Z. Theorie d. Wärmeregul. u. d. Balneotherap.,' *Pflüger's Arch.*, vol. iv. 1871.—Senator: 'Unters. üb. d. Wärmebild. u. d. Stoffwechsel,' *Reichert u. Du Bois Reymond's Arch.*, 1871.—Id.: 'Neuere Unters. üb. d. Wärmebild. u. d. Stoffwechs.,' ibid. 1874.—Id., in *Virch. Arch.*, vol. xlv.—Leichtenstern: 'Vers. üb. d. Volumen d. unter versch. Umständ. ausgeathmet. Luft,' *Zeitschr. f. Biologie*, vii. 1871.—Id.: 'D. Hämoglobingeh. d. Blutes.' Leipz. 1878.—Paalzow: 'Ueber d. Einfl. d. Hautreiz. auf d. Stoffwechsel,' *Pflüger's Arch.*, vol. iv. 1871.—Heinzmann: 'Ueb. d. Wirk. allmähl. Aender. therm. Reiz. a. d. Empfind.-Nerv.,' *Pflüger's Arch.*, 1872.—Tarchanow: 'Z. Phys. d. therm. Reize,' *Jahresb. f. Anat. u. Physiol. v. Hoffmann u. Schwalbe*, 1872.—Santlus: 'Ueb. d. Einfll. d. Chlornatr.-Bäder auf die Sensib. d. Haut.' Inaugural Dissert. Marb. 1872.—Riegel: 'Ueb. d. Beziehung d. Gefässnerv. z. Körpertemp.,' *Pflüger's Arch.*, v. 1872.—Id.: 'Ueb. d. Einfl. d. Nervensyst. auf d. Kreislauf,' ibid. iv. 1871.—Id.: 'Z. Lehre v. d. Wärmeregul.,' *Virch. Arch.*, 59, 1874.—Rosenthal: 'Z. Kenntniss d. Wärmeregul.' Erl. 1872.—Coloman Müller: 'Ueb. d. Einfl. d. Hautthätigkeit auf die Harnabsond.,' *Arch. f. exper. Pathol.*, vol. i. 1874.—Schleich: 'Ueber d. Verh. d. Harnstoffproduction bei künstl. Steigerung d. Körpertemp.' Preisgekr. Abhandl. Leipzig, 1875.—M. Schüller: 'Ueb. d. Veränd. d. Gehirngef. unter d. Einfl. äusserer Wasserapplic.,' *Deutsch. Arch. f. klin. Med.*, vol. xiv.—Nothnagel: 'D. vasomot. Nerv. d. Gehirngef.,' *Virch. Arch.*, 40.—Colasanti: 'Ueb. d. Einfl. d. umgeb. Temperat. a. d. Stoffwechsel d. Warmblüt.,' *Pflüger's Arch.*, vol. xiv. 1876.—Samuel: 'Ueb. Entstehung d. Eigenwärme u. d. Fiebers,' 1876.—Ostroumoff: 'Vers. üb. d. Hemmungsnerv. d. Hautgef.,' *Pflüger's Arch.*, 1876, vol. xii.—Latschenberger and Deahna: 'Beitr. z. Lehre v. d. reflect. Erreg. der Gefässmuskeln,' *Pflüger's Arch.*, xii. 1876.—D. Finkler: *Pflüger's Arch.*, xv. 1877.—Herzog Carl Theodor: 'Ueb. d. Einfl. d. Temperatur der umgebenden Luft auf die CO_2-Ausscheid. u. d. Sauerstoffaufnahme einer Katze,' *Zeitschr. für Biologie*, xiv. 1878.—C. Voit: 'Ueb. d. Wirk. d. Temper. d. umgebend. Luft auf d. Zersetzung im Organis. d. Warmblüter,' ibid. xiv. 1878.—G. v. Liebig: 'Ueb. d Veränder. d. Puls. im lauen Bade,' *Centralblatt f. d. med. Wissensch.*, 1878, 49.—Traube: 'Ueb. d. Wirk. d. lauen Bades,' *Gesammelte Beiträge*, vol. iii.—Stolnikow: 'Ueb. d. Veränd. d.

Hautsensibilität durch kalte u. warme Bäder,' *Petersburg. med. Wochenschr.*, 1878, 25, 26.

Among the handbooks of balneology quoted in the following pages I enumerate Ewich: 'Prakt. Handbuch üb. d. vorzügl. Heilquellen u. Curorte.' Berlin, 1862.—Kisch: 'Balneotherap. d. chronisch. Krankh.' Vienna, 1866. —J. Seegen: 'Handbuch d. allgem. u. spec. Heilquellenlehre,' 2nd edit. 1862. —Helfft: 'Handbuch d. Balneotherap.,' 8th edit., by G. Thilenius. Berlin, 1874.—Valentiner: 'Handbuch d. allgem. u. spec. Balneotherapie.' Berlin, 1876.—L. Lehmann: 'Bäder u. Brunnenlehre.' Bonn, 1877.—J. Braun: 'System. Lehrbuch d. Balneotherapie,' 4th edit., by Fromm. Berlin, 1880.

1. Action of Baths on the Temperature of the Body and on the Heat Store.

The baths employed in balneotherapy, in the narrower sense of the word, have a temperature, in the great majority of cases, differing little from the normal one of the body.

It is usual to call baths, which approximate in temperature to that of the body, thermally indifferent.

There is no fixed, unalterable degree of temperature of water, known as the thermally indifferent point, any more than there is any point of indifference of the air about us. The human body, like that of most warm-blooded animals, possesses the power of keeping its interior temperature constant, within a certain range and period, against varying influences of temperature. While in former days overdrawn pictures of this power used to be made, some authors have recently erred in the opposite direction, inasmuch as they attribute 'the boasted retention of animal temperature' chiefly to various instinctive or voluntary accommodations to external conditions (clothing, motion, house, nourishment, &c), and think that they may consider the slight variations of temperature produced by exposure to media of differing temperature, as evidence against the general law. In this they forget, that under the expression of 'constancy of the temperature of the body' it is not implied, that the interior temperature of warm-blooded animals is always the same and unalterable. We should rather say, that the constancy of the temperature of the body, the regulation of the radiation of heat according to the outside temperature, and the regulation of the production of heat according to the loss of it, are very striking phenomena, when we consider how slight the alterations of the interior temperature are, when the body

is exposed to the most different temperatures, especially cold ones, when the radiation of heat outwards is often enormously increased.

It is further often forgotten, that the constancy of the temperature of the body is shown almost absolutely when we compare the means of longer periods of time. The constancy of this mean appears, even when the person experimented on is exposed during a period of observation of several days to very different and very changing influences of the abstraction and of the addition of heat. It is Jürgensen's great service, that he has established the principle of compensation by a series of careful observations.

Those temperatures of bathing water are thermally indifferent, in which not only does the temperature of the body of the bather remain normal, but also the amounts of heat given off to the water, remain the same as would be given off in a similar period, by bodies during their ordinary exposure to the air.

It is evident that this point of thermal indifference, must lie deeper than the normal temperature of the skin, all the more so because in the bather, that portion of the normal loss of heat must be covered by the increased giving off of heat to the water of the bath, which under normal circumstances—that is, exposure to the atmosphere—would have been given off by radiation and transpiration.

The thermal indifference point of a bath lies between the temperature of 93·2° and 95°. The loss of heat which occurs in a healthy and not unusually fat man in a bath of a temperature of 93° to 95°, lasting 15 to 25 minutes, corresponds generally to the normal mean loss of heat (Liebermeister).

1. *A great many of the baths employed in balneotherapy coincide, with reference to temperature* (93·2° *to* 95°) *and to the length of the bath* (15 *to* 25 *minutes*), *with the thermal point of indifference. Such baths, as in them there is no change in the production or the giving off of heat, have no special thermal operation directly, either in a physiological or therapeutical point of view.*

We may enquire here whether thermally indifferent baths may not cease to be such, *by containing salts or gases stimulating to the nerves of the skin.*

The experiments hitherto made in this direction have been made entirely with baths not thermally indifferent—namely,

with cold brine baths. We shall see further on that cold brine baths, containing 3 per cent. of salt, do not differ from simple water baths of the same temperature, as regards giving off or production of heat (Liebermeister, Remboldt). It was not indeed probable beforehand, that baths containing salts or gases of indifferent temperature would operate otherwise—that is, thermally otherwise. But I have very lately made two experiments with warm salt baths of 5 per cent., and of temperatures of 93·2° to 95°, which showed that the indifferent salt baths also, did not differ in thermal operation from simple water baths of the same temperature. I shall have to return to this experiment hereafter.

Since then, according to the present state of our knowledge, it is only in the case of concentrated baths that we can speak of the salts stimulating the skin, and nothing is actually known of the specific stimulant action of the individual chemical constituents of a bath, I think I am justified in laying down the following proposition :—

2. *Baths containing salts of the concentration usual in baths, if their temperature coincides with that of the thermal point of indifference, have no specific, indeed no influence at all, on the temperature of the body, its giving off or its production of heat; and are not in these respects distinguishable from simple water baths of the same temperature. It is highly improbable, that the baths containing various gases differ in their operation from salt baths, as far as the power of stimulating the skin is concerned.*

The idea, that so called skin-stimulating baths of indifferent temperature and containing salts or gases operate otherwise than simple water baths, has been repeatedly brought forward on the ground of certain interesting physiological researches. R. Heidenhain's exact experiments on animals have shown with certainty, that the mechanical and electrical stimulation of the nerves of sensation (and partially also of the medulla oblongata) causes a sinking of the temperature of the body. This lowering of the temperature is produced by the change in the circulation caused by those experiments, inasmuch as greater amounts of blood than before pass in the same space of time through the colder periphery of the body (Heidenhain). While in this way the temperature of the periphery is raised, and

along with this the radiation of heat from the surface increases, a fall in the temperature of the interior of the body must take place. Ostroumoff showed that the acceleration of the blood stream in the skin, discovered by Heidenhain, was caused by a dilatation of the vessels of the skin (stimulation of the nerves of the skin, which causes expansion or contraction of the cutaneous blood vessels).

As, then, in applying 5 per cent. salt baths of indifferent temperature, I observed neither a depression of the internal temperature of the body nor an increased giving off of heat to the bath water, it becomes probable from this, that any stimulation of the skin from salt or other so called stimulating baths cannot be regarded as of the same nature, as regards amount of stimulation or of operation, as the electrical or mechanical stimulation applied by physiologists to nerves that have been laid bare.

The question, whether skin-stimulating baths of indifferent temperature have perhaps some influence on the heat of the body and its production, requires to be considered still from another point of view. Röhrig and Zuntz found in their experiments, which will have often to be quoted hereafter, that in a 3 per cent. brine bath of the temperature of 96·8° the consumption of oxygen and the excretion of carbonic acid were distinctly increased in rabbits. From this influence of brine baths in quieting irritability of the nerves of the skin, it would be easy to draw further conclusions as to an increase of oxidation or of heat production, as to an increase of the temperature of the body, or its remaining equable, with an increased radiation of heat, all caused by irritation of the nerves. But this way of drawing conclusions is inadmissible, as long as we do not know whether the increased excretion of carbonic acid observed in the rabbits, went hand in hand with increased production of heat, and so long as we have no direct proof that there are an increased excretion of carbonic acid and production of heat, in man under the influence of warm baths containing 3 or more per cent. of salt.

It is improbable that the stimulation of the skin by carbonic acid in a bath, as respects production of heat and temperature of the body, can be more powerful than that by the salt contents of a bath, but Paalzow has not been able to observe, even in rabbits, that 3 per cent. salt baths react in that way, nor that there is any increase of excretion of carbonic acid or increased taking up of oxygen in a bath containing carbonic acid.

Least of all are we inclined to apply to the condition of salt or gas baths the results of painful experiments made on shaved rabbits by rubbing in croton oil or spirits of mustard.

Another question is, whether indifferent warm baths are able in

their secondary effects to influence the radiation of heat, and so the temperature of the body and the production of heat. There are no researches on this subject. It cannot well be denied, that after a bath of long duration a certain amount of imbibition and soaking of the most superficial layers of the epidermis occurs, nor that after a bath, even after the drying of the surface, a certain amount of water remains behind in the folds and depressions of the skin. This gives us the possibility of a stronger evaporation of water after a bath, and also with it the possibility of the increased cooling of the surface, along with its natural effects on the heat of the interior and the production of heat. An important part, however, is played in this, by the external relations to which the patient is submitted after his bath (clothing, temperature, draught of air, hygrometrical state of atmosphere, &c.) On these in reality the quickness of the evaporation depends. It is not known what is the amount of the water that has been imbibed by the epidermis, or retained by the skin after a bath. Attempts to ascertain it by weighing, have not been successful. The average quantity of water lost by the skin in ordinary transpiration in the hour is about 25 grammes. The amount of heat which is stored by the evaporation of this amount of water, is about $14\frac{1}{2}$ calories.[1] Supposing we make the improbable assumption, that 100 grammes of water, divided equally over 1·6 square metre of the surface of the body, evaporate within an hour after a bath, on account of the imbibition by the superficial layer of the epidermis, the quantity of heat taken from the body in an hour would amount to 58 calories, a very distinct amount, if we take into consideration that the whole amount of heat, which a man weighing 60 kilogrammes loses in the hour, is about 92 calories.

3. *After an indifferent bath, and indeed after any kind of bath, an increased loss of heat, indefinite, but varying according to external circumstances, may occur, because the increased amount of evaporation from water that has been retained in the skin, stores heat.*

Although most of the baths employed in balneotherapy are in the great majority of instances thermally indifferent, the thermally indifferent temperature of 93·2° to 95° is often exceeded, or is not attained, and it is worth remembering that the relations of parting with heat and production of it, vary very

[1] French thermal units—the amount of heat required to raise the temperature of water to 1° centigrade. The French unit = 2·2 of English heat unit. —*Tr.*

quickly and in no inconsiderable degree with distance from the thermal point of indifference.

Although the description of the thermal operation of cold and hot baths belongs to hydrotherapy, yet I must recapitulate its chief points briefly.

If we turn first to cool and cold baths, the first important law is as follows :—

4. *All researches agree in giving the result, that during the operation of an unusually strong withdrawal of heat from the outer surface, if its intensity and duration does not exceed certain limits, the temperature of the interior of the body does not sink, but rises slightly* (Liebermeister).

This fact, discovered by Liebermeister in 1859, and confirmed by a series of observations on man (to which Hoppe had called attention in 1857 in his experiments on dogs), is now universally received. Liebermeister found that in a healthy man of normal bodily temperature, exposed to the operation of moderately cold water (temperature 69°) on the surface of the body during a moderate time, the temperature in the axilla does not sink, but rather rises a little. Kernig observed the temperature in the axilla remain constant, or rise a little, in a bath of a temperature of 77° to 86° continued for 33 minutes. Jürgensen also showed that the temperature of the rectum, measured during the operation of cool baths (86° temperature, 25 minutes' duration), does not sink, but rises slightly.

On the other hand the temperature even of the interior falls, if the abstraction of heat is of considerable intensity or duration. Thus Jürgensen found, that baths of temperature 48·2° to 51·8° usually caused a rapid sinking of the temperature of the interior, and even that baths which only abstract heat moderately, if continued for an unusually long time, cause a depression of temperature in the interior. In most men cold baths of a temperature of 68° to 75° can be borne on an average 15 to 25 minutes, before the temperature sinks below what it was at the commencement of the bath (Liebermeister).

5. *After the discontinuance of an abstraction of heat, not of excessive intensity or duration, during which the temperature of the body remained constant or even rose a little, a period follows, when the temperature of the body becomes lower than it was before the bath* (primary after effect, Liebermeister). *To this stage of cooling succeeds a slight compensating rise of the heat of the body* (secondary after effect, Jürgensen).

The primary after effect, or cooling of the interior of the body, after the heat-abstracting process is given up, is chiefly occasioned by the alteration of the circulation after the bath, inasmuch as the contraction of the peripheral vessels is relaxed, and the rapidity of the circulation through the cooled-down periphery increases. By this means the radiation of heat from it is increased, and a depression of the temperature of the interior of the body is a necessary consequence. But this lowering of the internal temperature is partly caused, as Liebermeister has shown, by a diminution of heat production after the bath, as a compensation for the greatly increased heat production during the bath.

6. *Local abstractions of cold from the skin, in the form of cold douches, wet packings, half-baths, &c., are also not followed by any sinking, but rather by a rising of the temperature of the interior, and therefore may be regarded as slight general withdrawals of heat.*

We owe to Liebermeister not only the above-described researches respecting the temperature of the body, but also a further very remarkable series on the subject of the parting with heat and production of it in the use of cold baths, which throw much light on the heat economy of warm-blooded animals. We offer here an abstract of some of his most important conclusions, referring for further information to Liebermeister's classical work, 'The Pathology and Therapeutics of Fever.'

7. *The loss of heat in a healthy man is immensely increased in a cold bath, and the amount of loss is proportionate to the degree of difference of temperature.*

If we observe, in a man who is healthy and not unnaturally stout, the loss of heat which takes place in a bath of the duration of 15 to 25 minutes, it is found that in a bath of the temperature of 93·2° the loss of heat nearly corresponds with the ordinary average loss; in a bath of 86° it reaches twice, in a bath of 77° three times, in a bath of 68° more than five times the ordinary average loss.

8. *The constancy of the temperature of the body in a cold bath is occasioned by the balancing both of the loss and of the production of heat.*

The chief circumstances which balance, i.e. diminish, the loss of heat in a cold bath, consist in the cooling of the skin, by means of

which the difference of temperature between it and the colder surrounding medium becomes smaller, and the parting with heat is necessarily retarded; further, in contraction of the vessels of the skin, whence it results that less than the normal amount of blood circulates in the cooled-down periphery.

If we consider the enormous loss of heat which the body sustains in a cold bath, while the interior temperature of the body remains constant, the suggestion is presented to us, that there must be a production equivalent to the loss of heat. It is Liebermeister's great service that he has proved by a series of experiments the truth of this assumption. Liebermeister showed that the equalisation of the temperature in the cold bath is not sufficient to explain the constancy of the interior temperature, and that it must be caused by increased production of heat.

9. *In a cold bath the production of heat is increased in a marked degree (it is often twice or thrice as much as the normal). The production of heat is proportionate to its loss.*

For explanation of this I refer to Liebermeister's work already cited. We shall have occasion to examine afterwards, when we come to consider the effect of baths on transformation of tissue, the increase of carbonic acid which accompanies the increased production of heat.

This seems to be the proper place for us to cast a glance on the mode of operation of the various mechanisms which regulate heat production, all the more so because in balneotherapy, when the operation of baths as skin stimulants is discussed, various and often not very fortunate deductions are founded on the mechanics of the balance of heat.

The mechanism of the balance of the loss of heat in a cold bath is on the whole intelligible. The stimulus of cold produces, partly directly, partly by reflex action (by excitement of the cutaneous nerves), contraction of the vessels of the skin. Some believe that the reflex contraction of the vessels is greater, if the stimulation of its salt or gas contents is added to the simple stimulation of the cold of the bath. This union of stimuli is supposed by some to produce an excess of stimulation, of which the immediate consequence is a remission of the contraction of the peripheral vessels. It is self-evident, that under such circumstances the loss of heat in a cold salt bath would be altered in an important degree, i.e. increased. But we know of no ex-

periments which support this view. On the contrary, Liebermeister's and Rembold's experiments with cold brine, and mine with warm brine baths of indifferent temperature, show no difference in the loss and production of heat, from what occurs in simple water baths.

If the stimulation of a bath, containing salt or gas, were in its operation equivalent to the stimulus of cold, then one should, on entering an indifferent salt bath, perceive a distinct chill, and there would be paleness of the skin, effects which everyone knows do not occur.

It is important that we should distinguish very thoroughly two different stimulations so wide apart, as the stimulus of cold, and that which is produced by the salts or gas present in the bath, especially when it is our object to enquire into the operation of the nervous system on the balance of heat production.

We meet with a greater divergence of opinion in answering the question, What are the ways of regulating heat production? There is complete agreement of opinion that the nervous system is its great adjuster. The excitement of certain afferent nerves is propagated to the brain (the centre of the brain and medulla oblongata), and excites there certain centres (centres which excite and moderate heat) from which the stimulation is carried, according to the laws of reflex movement, to such efferent lines of nerves as directly or indirectly (by acting on certain circles of vessels) exercise an influence on the process of oxidation.

Some consider it proved, that the stimulus of cold to the cutaneous nerves excites reflexly the production of heat. The supporters of this view dwell very fairly on the wonderful richness of the skin in nerves, on its delicate sense of temperature, which, according to some pathological researches, is probably dependent on special nerve twigs which perceive temperature. These, according to the views of some, represent the afferent lines which reflexly influence the production of heat.

I cannot here enter into the numerous, and interesting, and also contradictory results of physiological experiments, which have been made to determine the seat and the mode of operation of the centres in the brain, which excite and regulate heat. I must content myself with giving something of what different

investigators say about the production and regulation of heat by the nervous system.

Röhrig has endeavoured to prove the influence of skin irritants on the temperature of the body by numerous experiments on rabbits. The irritants employed by him were mostly of a chemical nature, and were chiefly croton oil, tincture of cantharides, spirit of mustard, which were rubbed into the muscles of the ear or into shaved surfaces (2 to 3 □″) of the skin of rabbits. According to Röhrig all skin irritants act in the same way, and differences in their action depend only on the intensity of the irritant. If the irritation of the skin was strong, the temperature of the interior was found to sink, while the application of mild irritants seemed to increase it more or less. The rise of temperature (and of course the regulating of the normal temperature) is caused, according to Röhrig, by this, that cold, like all other sensible stimulants of the cutaneous nerves, calls forth reflexly a minute and commonly not recognisable contraction of the striated muscles, which are the most important seat of heat production, and that this occasions the oxidation of material containing carbon and the generation of heat. Weak irritation of the skin nerves is said (1) to diminish the loss of heat by contracting the calibre of the peripheral vessels and by retarding the respiration, (2) to increase the production of heat by reflex contraction of the striated muscles. The circumstances are more complicated when the skin stimulation is stronger, which is attended by a sinking of the temperature of the body. In this case, according to Röhrig, the contraction of the peripheral vessels is supposed to follow immediately the expansion of the vessels caused by the higher stimulation, and thus to induce a distinct increase of the loss of heat. Undoubtedly the increased giving off of heat would be partially compensated, both by a simultaneous excitement of heat production (reflex contraction of the muscles) and also by the retardation of the respiration and of the pulse, caused by the stronger skin stimulation (diminution of the heat given off by the lungs, retardation of the circulation); but this compensation would be insufficient, and the temperature of the body sinks owing to the abnormal amount of parting with heat. This is not the place to enter into an examination of Röhrig's meritorious researches; I would

only remark that experiments on man, with cold baths containing 2 to 3 per cent. of salt, have shown that the giving off of heat, its production, and the temperature of the body are just the same in them, as in simple baths of the same temperature, and that my experiments with 5 per cent. baths of indifferent temperature (therefore salt baths that ought to stimulate the skin) have not led to any different results, as far as regards the giving off of heat or the temperature of the body.[1]

Winternitz thinks that he can explain in another way the increase, which he does not entirely discredit, of the production of heat during its withdrawal. His explanation of the phenomenon is as follows: 'The skin is supplied with blood only (! ?) by the lateral and terminal capillaries of the muscular system: and if they contract, the pressure and the amount of blood must increase in the muscles. Along with this the temperature of the muscular sheath must rise, and thus all conditions for the increase of its function are supplied, i.e. the production of heat (! ?).' While the cutaneous vessels contract under the stimulus of cold, a collateral hyperæmia of the muscles occurs, especially when a reflex contraction of the vessels of the muscles does not take place, as is to be concluded from the experiments of Hafiz, who was unable to detect any contraction of the vessels of the muscles when the vasomotor centres were stimulated.

Liebermeister doubts, on very good grounds, whether the regulating of the production of heat according to the loss of it, depends principally on the agency of the sensory cutaneous nerves. 'We have to seek for the layer which regulates the production of heat at a certain depth under the surface, either at the inner border of the fatty tissue under the cutis, or in the superficial layers of the muscles of the body. The regulating layer stands in connection with the regulating central organs by afferent nerve lines; and the production is regulated by the central organs through the efferent nerve lines. From all experience it appears to be highly probable, that the muscles are the organs in which a specially intense generation of heat

[1] I shall have an opportunity afterwards of examining those researches more fully.

takes place, and which are specially concerned in the regulation of heat production' (Liebermeister).

From what has been said the following proposition, among others, follows :—

10. *As far as researches up to the present time go, there is no ground for the assumption that baths containing salt or gas act in any way differently from simple water baths of the same temperature, as respects giving off or production of heat or the temperature of the body.*

If we turn next to warm and hot baths, we have only space here to enumerate briefly their chief laws. For details we refer to the chapter on Hydrotherapy.

11. *If the normal loss of heat is prevented by the use of baths which warm the skin, or if it is so by the use of baths hotter or warmer than the skin, warmth is brought to it from the exterior, the heat produced in the body accumulates, and a rise of the temperature of the body is its consequence.*

When the giving off of heat was entirely prevented, the temperature rose in a full-grown man about 4·5° in every half-hour (Liebermeister). In a bath, the temperature of which was kept constant at that of the closed axilla, Liebermeister observed a rise in the temperature of the axilla in 55 minutes of from 99·5° to 102°. In a man of the weight of 80 kilos. the temperature of the axilla was under similar conditions raised from 99° to 102·4°. In hot baths of 104° to 111·2° temperature Mosler observed during the bath a rise in the temperature of the mouth to 101·6°. It is self-evident that the supply of heat is much greater in hot baths, than in hot air or vapour ones of the same temperature. Further, the staying in dry hot air is more easily borne, and raises the temperature of the body less rapidly, than staying in hot air saturated with steam. The rapid increase of the temperature of the body in a vapour bath is a familiar fact. To give only one instance, Bartels has seen the temperature of the rectum of a man of 51 kilos., in a vapour bath of 127·4°, rise in 10 minutes from 100·4° to 104·5°. In a vapour bath of 123·8° the temperature of the same individual rose from 100·4° in 8 minutes to 103°, and in 30 minutes even up to 107° (!) Schleich, Jürgensen, Schuster, and many others have made similar observations on the increase of the temperature of the body in hot baths.

As to the condition of the temperature of the body after hot or warm baths, sufficiently long-continued observations have led to this

result, that to the stage of increased temperature of the body during the bath, there succeeds a corresponding period of its depression. The law of compensation described by Jürgensen applies here also.

We have no observations that are decisive and not open to objections, respecting the conditions of the production of heat in warm and hot baths. In warm baths of the temperature of 96° to 96·8°, and lasting 35 minutes, in which the temperature of the body scarcely rose, Kernig found on the average of six experiments the production of 1·06 calories in the minute, while the normal production of heat by the person experimented on had been with reference to his weight 1·5 calorie. But we must not from so imperfect an experiment draw the positive conclusion that there really was a diminution of heat in this case, though it is probable enough.

It is different, again, if the loss of heat in warm or hot baths is prevented in such a way that a considerable rise of the temperature of the body is induced. In that case even a slight increase of the production of heat takes place, as Liebermeister has convincingly proved by experiments.

2. Operation of Baths on Change of Tissue and on the Excretions.

The opinion is universally spread and is deeply rooted, that change of tissue is influenced in an important degree by the use of different kinds of baths, and that in this is to be found a large portion of the physiological and therapeutical effects of baths. We meet everywhere with remarks and laudatory expressions about 'mild excitement,' or 'powerful stimulation of change of tissue.' If we endeavour to examine more closely on what fact those phrases about change of tissue rest, we find that they are almost entirely derived from the changes which are observed during bath cures in the weight, in the appearance, in the physical condition, and in the feelings of the patient. We also very often ascribe to bathing and to drinking, what in the most favourable cases is the result of a very intricate complex of causes. Among these, bodily exercise, altered diet and mode of life, climatic and psychical factors, occupy an important if not the first place.

We are almost entirely without adequate observations respecting the whole change of tissue during the use of cold

and warm simple baths, as well as of mineral baths—observations in which the strict, indispensable conditions of an experiment on change of tissue should be observed.

On the other hand, we have a series of exact investigations into the changes which take place in the excretion of one or other of the products of change of tissue, i.e. of carbonic acid and of urea, during the use of cold, warm, and hot baths. These researches have enriched our knowledge of the direct influence of cold and heat on the process of the formation of carbonic acid and the decomposition of albumen. We must here also confine ourselves to the more prominent facts.

12. *The cold bath, as well as all procedures which distinctly increase the loss of heat (cold sponging and sitz baths, uncovering the body in cold air, &c.), produce an increase of the excretion of carbonic acid, and also of its production. The increase of this is proportional to the increase of the loss of heat, i.e. the production of heat.*

This fact has been elicited and fully proved by Liebermeister by numerous experiments on men, with the help of the respiratory apparatus constructed by him. Even in a bath of 90·3° the excretion of carbonic acid was a little greater than under normal circumstances; in really cold baths of 64·4° it increased to three times the normal amount. The increase of the excretion of carbonic acid also continues for some time after the cold bath, and the excretion only gradually returns to the amount before the bath, or when in it. From this circumstance, and from the proportion which exists between the magnitude of the loss of heat (i.e. of the production of heat) and the increase of the excretion of carbonic acid, it follows that the latter is the result of an increased production. In addition Röhrig and Zuntz have shown in their experiments on rabbits, that the increase of the excretion of carbonic acid in the cold is accompanied with a corresponding increase of the consumption of oxygen. Cold baths of excessive duration, and which abstract much heat, and in consequence cause a fall of the temperature of the interior, lead to a diminution of the production of carbonic acid and of the consumption of oxygen.

As long as the temperature of the bather is kept nearly con-

stant in cold baths, the production of heat, the excretion of carbonic acid, and probably the consumption of oxygen are increased the more, the greater the loss of heat, proportional to the degree of cold, is. If, again, in cold baths the temperature of the bather is considerably reduced, as is the case when there is an excessive abstraction of heat or excessive duration of the bath, the excretion of the carbonic acid and the consumption of oxygen sink along with it.

It is further highly probable that the law of compensation applies to the excretion of carbonic acid for some time after the cold bath—i.e. that, for some time after the bath, the excretion of carbonic acid remains under the normal amount. In that case the amount in the twenty-four hours of carbonic acid, might be the same on days with cold baths, as on days without them.

The increase of the excretion of carbonic acid, and indeed its production in the cold, have been observed by all who since Liebermeister have made accurate observations in this direction. I refer only to the experiments of Röhrig and Zuntz on rabbits, of Colasanti, and Dr. Finkler on guinea-pigs, of Duke Carl Theodor on the cat, as well as to the very important researches of Carl Voit on the operation of the temperature of the surrounding air on decomposition of the organism of warm-blooded animals.

13. *The increased decomposition of non-nitrogenous matters in the animal body under the use of cold baths, is caused by the effect of the cold on certain nerves of the periphery; there is reflexly an increased conversion of fat, caused by the action of the cold* (C. Voit).

There appears to be at present general agreement concerning this proposition, and also no less, that the reflexly increased change of tissue takes place, chiefly in the muscles. Various experiments of Röhrig and Zuntz, Pflüger and Colasanti, of Samuel, C. Voit, and others make it impossible to doubt the soundness of this conclusion.

If the stimulus of the cold of the bath reflexly increases the conversion of fat and the production of carbonic acid, the question, important for balneotherapy, arises, whether other stimulants to the skin, such as the salt or gaseous contents of a bath,

are in a position to exercise a similar effect on the conversion of tissue.

Paalzow, a scholar of Pflüger's, observed after the application of a mustard poultice to a tied up tracheotomised rabbit, without any increased muscular movements of the creature, an increased excretion of carbonic acid and an increased consumption of oxygen, but could observe no such effects from the application of baths rich in carbonic acid. It follows from these experiments, that to produce a reflex increase of conversion of tissue, it requires a strong stimulant to the skin, and it is a question, whether the salt or gas baths usually employed in balneotherapy, can be regarded as such. Röhrig and Zuntz found that when they dipped a rabbit in a 3 per cent. sea salt bath of 96·8°, there was a greater consumption (15·3 per cent.) of oxygen, and a greater formation (25 per cent.) of carbonic acid, as compared with an equally long stay in a simple water bath of the same temperature. In the salt bath, the amounts of the oxygen taken up, as well as of the decomposed carbonic acid, exceeded the amounts got in the simple water bath of the same duration by double, while in the concentrated salt bath they rose still higher. Thus the acceleration of the oxidation kept pace with the increase of skin stimulation.

As far as we know, no complete observations that are not open to objection, have been made in man, on the excretion of carbonic acid in full baths containing salts or gas. The experiments of Liebermeister and Rembold, who found that the production of heat in a 2 to 3 per cent. salt bath took the same course as in a bath of simple water of the same temperature ; our own experiments with 5 per cent. indifferent warm baths, which also showed no difference as to the loss or the production of heat in them and in those of plain water ; and finally Paalzow's above-mentioned experiment with a carbonic acid bath in rabbits, render it probable that,

14. *The stimulus of the salt or gas of the mineral bath usually employed in balneotherapy, is commonly too weak, unless perhaps in the case of a particularly sensitive skin, to increase reflexly the conversion of fat and the production of carbonic acid, as the stimulus of the cold of the bath may do.*

There are no observations on the production of carbonic

acid in man in warm and hot baths. In the lukewarm bath, which diminishes the loss of heat, without perceptibly raising the heat of the body, there is most probably a diminution of the excretion of carbonic acid. This conclusion might have been drawn from the earlier experiments of Vierordt, Letellier, G. Lehmann, Barral, E. Schmidt, and Sanders-Ezn. But the researches which were carried on in Pflüger's laboratory by Röhrig and Zuntz, Colasanti and D. Finkler, showed quite specially that the excretion of carbonic acid and the consumption of oxygen diminish in the higher temperature. The slight diminution of heat production in a warm bath, which was observed by Kernig (see above), agrees perfectly with these important results.

But if the temperature of the body is considerably increased in a hot or a vapour bath, then an increase of the conversion of tissue takes place, with increase of the excretion of carbonic acid and of the consumption of oxygen, just as, on the other hand, both are diminished when the temperature of the body is considerably reduced in a cold bath.

We have many experiments concerning the relations of the conversion of nitrogenous constituents of the body during the use of various simple and mineralised baths, but few of them answer to the requirements demanded in modern times of a well-conducted experiment in the conversion of tissue. It is obvious enough—nevertheless it has been overlooked in many of the experiments hitherto made on this subject—that we have not to do with the analysis of urea only, that at least an equality of the excretion of nitrogenous matter must be obtained by a suitable regulation of the food taken, before we can think of proving the influence of baths on the breaking down of albumen.

15. *The decomposition of albumen, i.e. the excretion of urea, is not altered in a cold bath, unless the temperature of the body is considerably lowered by it.*

Liebermeister found, in experiments which he made in the years 1859–60 on the question whether the quantities of urea excreted are altered by great withdrawals of heat, that they cause no evident increase of the excretion of urea in men living alike and on like diet. According to Senator's experiments on dogs fed alike, low external

temperatures produced no change in the excretion of urea. Voit's experiments also do not show any observable increase of the consumption of albumen in the cold, as compared with the mean temperature of 60·8°. 'It is, however, probable that when there is a lowering of the animal heat, there is a decomposition of albumen along with a decomposition of fat, as is shown by the marmot in hibernation, when we have to consider the conditions of the decomposition in the cooled-down cells' (C. Voit).

The warm bath has therefore no effect on the decomposition of albumen, as long as the temperature of the body is not increased by it. But it is different when it is so increased.

16. *The hot or vapour bath, &c., which increases the temperature of the body, occasions an increase of the excretion of urea, i.e. an increased decomposition of the constituents of the body which contain nitrogen.*

Bartels observed in men, the temperature of whose bodies had been temporarily raised artificially by vapour baths, an increase of the production of urea, which lasted for some little time after leaving the vapour baths. Naunyn too also found the amount of urea increased in dogs whose temperature had been artificially raised. G. Schleich has finally settled this question by a series of most careful experiments. He discovered a marked increase of the excretion of urea on days, when the temperature of the body was raised to 103° and more, by means of hot baths. This continued in a slight degree for some days after the hot bath, and was succeeded by a compensatory decrease of urea. Schleich's results are the most certain, because the person experimented on was, by a uniform diet during the 30 days' period of the enquiry, kept in a tolerably satisfactory condition of nitrogenous equilibrium.

17. *It is in the highest degree doubtful whether the influences, which have been above described, of the cold and warm baths on the conversion of albumen, and the excretion of urea, are altered by the use of salt or gas mineral baths.*

There is no want of experiments which ascribe to mineral baths special effects, i.e. such as differ from those of ordinary water baths, on the change of tissue. While the great majority of these so called experiments on change of tissue, do not answer the most primitive requirements of researches which are so difficult and which require so much care, Flechsig has bestowed much pains (in his researches on

the mode of operation of lukewarm iron and simple water baths) on the chemical analysis of the ingesta and of the fluid and solid excretions. The gaseous baths could not be reckoned, owing to the want of a suitable apparatus. He did not content himself with the known elementary composition of the various articles of nourishment, and with the quantitative indication of the most important constituents of the urine and the fæces, but undertook the unnecessary trouble of analysing to their elements, what was taken in as well as what was given out.

It is evident that the certainty of his conclusions is not increased by this method, and we cannot be surprised that many of this author's conclusions rest on figures, which may be by no means free from errors of observation. The whole method of Flechsig's experiment also was not one, which could prove anything about the alterations in the change of tissue produced by the use of lukewarm baths. It is sufficient to remark, that Flechsig for the first five days analysed all ingesta and egesta (gaseous ones excluded); then he took daily for two weeks a simple water bath, or during the other fresh series of experiments an iron one, and he allowed his amount and mode of nourishment during this two weeks' period of bathing to depend on his appetite. Three days after the last bath, he commenced again the analysis of the ingesta and of the fluid and solid excreta, and he continued this for five days. The differences thus found, i.e. between the first and the last analysis, he set down to the operation of the baths.

I do not think it necessary, after what has been said, to examine the special effects which, according to Flechsig, lukewarm plain and lukewarm iron baths have on change of tissue.

If we review the influence, which has been above described, of cold and warm baths on the change of tissue, and if we observe that cold baths increase the conversion of fat, that hot baths, which raise the temperature of the body, increase the conversion of fat as well as the decomposition of albumen, the question now suggests itself, *whether this influence of cold and hot baths on change of tissue is also in a position to produce therapeutic effects in pathological conditions, i.e. in disease.*

This question can certainly not be answered in the negative. If it is the object to subdue the tendency of the system to put on too much fat, then cold and also hot baths, which increase the conversion of fat, can come into useful operation. But the use of the baths must be supported by a corresponding change in diet and in mode of life, by increased bodily exercise, by a pure

or modified Banting diet, by the use of purging mineral waters, i.e. such ones as remove nutritious matters, or of such as increase the conversion of albumen (those containing chloride of sodium), and by abundant water drinking.

It is possible that the influence of cold and hot baths on the change of tissue may be also worthy of consideration therapeutically in another point of view—namely, on the assumption (no doubt a far from proved one) that pathological products in the body (exudations, hyperplasias, new formations, &c.) are more easily drawn into solution (i.e. increased change of tissue) than its fluid or solid normal tissues. If the increased conversion of fat produced by cold or hot baths, would extend itself to the fats contained in pathological products, exudations and new formations; if the increase of the temperature of the body by the use of hot forms of baths, would favour the conversion of those albuminates, which are constituents of pathological products, in a higher degree than the conversion of the normal albumen of the organs and of the circulation—then, indeed, the therapeutic value of cold and warm baths could be theoretically explained, and its cause be made plain.

I do not doubt the probability of this being one day proved, but until it is so, I cannot formulate what I have said, into a positive proposition. I must submit one less favourable to the claims of balneotherapy.

18. *Inasmuch as most of the baths used in balneotherapy are in most cases thermally indifferent, the influences which have just been described of cold and hot baths on change of tissue —that is, the excretion of carbonic acid and of urea—do not come within their sphere. Such baths must be regarded simply as indifferent, all the more so, because the degree of skin stimulation which these baths produce by means of their contents in salt or in gases, is usually too slight to influence in any marked degree the processes just mentioned.* (Comp. Prop. 17.)

Accurate observations on this subject, conducted in a way not open to objection, are urgently wanted.

It will be of course understood, that in what has just been said, it is not pretended to say that the change of tissue is not influenced by baths of indifferent temperature, whether of simple or of mineral water. When in the course of a bath cure we

see the appearance of a patient improve, and his weight increase, this is without doubt the result of processes of tissue change, in which most probably the increased putting on of flesh, had been preceded by increased and modified change of tissue. Such a body may have become by the bath cure richer in albumen of the circulation and of the organs, and richer in fats and salts, and may at the same time have become poorer in water. But we are not permitted to assume, merely from the simple observation of increase of weight and of better state of nutrition, that this effect has been caused by the bathing, that the bathing has of itself, or by its contents of salt or gas, 'powerfully stimulated, increased, altered, and modified the change of tissue,' to use one of the flowery expressions of balneotherapy. We know that numerous factors co-operate with the bathing or drinking cure, among which the dietetic, the climatic, and the psychical are at least as important as the drinking or bathing. Nevertheless we cannot *a priori* deny that baths containing salt or gas, even although they are thermally indifferent, may by their stimulation of the cutaneous nerves possibly influence the finer processes of change of tissue both directly and indirectly, the last by influencing the secretions, the distribution of blood, the movement of the lymph, &c. But this remains only an *a priori* possibility, until either the reverse is proved, or some stringent proof is adduced that mineral water baths do in one way or other influence tissue change.

What we have remarked respecting the influence of baths on change of tissue, applies equally to the phrases used with such confidence in balneotherapy, as 'powerful excitement of blood-making,' 'beneficent vivification of the blood mass,' 'blood moulting,' and the like. If by such phrases it were only intended to say, that in the course of bath cures the pale and sickly look of many patients alters, and gives place to a better colour of the skin and mucous membranes (for, as far as I know, balneological literature does not contain any actual blood analyses, not even any counting of the solid blood corpuscles or exact determinations of the amount of hæmoglobin), there would not be so much to say against such expressions of a simple fact. But the unwarrantable conclusion is often drawn from these phrases, that this or that bath is able to exercise such a powerful influence

on the quantity or quality of the blood. Here also in explaining the factors of cure, their smallest part (*modesta pars*) is made to stand for the whole. In this way, going on with the drawing of conclusions, one at last arrives at the desired result, that the iron or the salt of the baths produces that, which in the most favourable case is only the developed sum of all the factors.

The question may be asked whether a marked alteration of the excretion of carbonic acid by the skin can be induced by cold and warm baths, and especially by mineral ones that stimulate the skin. Many are inclined to attach great importance to this question. Inasmuch as the bath operates as a cleanser of the skin, opens numberless sweat and sebaceous follicles and pores, frees the skin from dirt and old epidermis scales, and makes it more pliant, while the bath, especially the salt and gas containing one, as it is assumed, expands the vessels of the skin and augments the flow of blood to the surface, people are apt further to conclude, that it can alter the conditions of the respiratory action of the skin and of its excretion of carbonic acid. Röhrig made experiments on the yield of carbonic acid and of water through the skin (to which we shall have to return) by introducing the arm air-tight into a tin box a metre long. This showed that the yield of carbonic acid by the skin is subject to considerable variations. Röhrig found, what Gerlach and Aubert had already seen, that a very slight increase of the yield of carbonic acid takes place with a rising temperature of the surrounding atmosphere. Stimulation of the skin (strong friction, faradisation, rubbing in spirits of mustard) caused a distinct increase of the excretion of carbonic acid.

Interesting though these experiments of Röhrig are, still we cannot attach any importance to the increased excretion of carbonic acid by the skin during or after simple or skin-stimulating baths, not even when we learn that this increase may amount to 50 per cent. The yield of carbonic acid by the skin, even when doubled, is but a very trifling one when compared with that of the lungs. The carbonic acid given off by the skin in twenty-four hours amounts, according to Scharling, to about 10 grammes, or according to Aubert to 3·9 grammes. It is therefore only about the $\frac{1}{220}$th part of the yield of the lungs. The respiratory function of the skin is so slight, that a temporary increase of the cutaneous excretion of carbonic acid, even if doubled in amount, can have no physiological or therapeutical importance.

My description of the influence of baths on tissue change will naturally conclude with the question, of their eventual operation on the excretion of water through the skin and

kidneys, and also on the excretion of the solid constituents of the urine, urea excepted (the behaviour of which has already been shortly described).

As long as the body is in a bath, the evaporation of the water from the parts covered ceases. People have thought that they might attribute to this suppression of 'a weighty function of the skin' a certain importance. The evaporation of water from the skin under normal conditions usually amounts, on an average, to 600 grammes per day. If we assume a visit of one hour's duration to the bath, and neglect the small amount of water which evaporates during it from the portion of the body not immersed, the quantity of water that remains behind, along with the diminution of the watery perspiration, amounts to 25 grammes! It is plain that such a suppression is really of no importance, and all the more so, because the organism is able by deeper and more frequent inspirations, and by an increased secretion of urine, to free itself easily of the amount of water supposed to be retained.

As heat becomes stored by the evaporation of water from the surface, many think that the suppression of this function in the bath, can make a considerable alteration in the heat store of the system. Here too the simplest calculation shows the extravagance of such an assumption. If in one hour 25 grammes evaporate from the skin, the loss of heat that accompanies it amounts to 14·5 calories, while the whole normal loss of heat per hour for a man of the weight of 60 kilos. amounts to about 92 calories. But the loss above mentioned of 25 grammes of water per hour, can be easily made up by an increased respiration.

On the other hand it cannot be denied, that there is an increased evaporation of water from the skin after a bath. We have shown above (see p. 261) that in this way the loss of heat may be increased, it being naturally premised that the loss of water from the lungs, caused by altered mode of breathing, is not diminished in the same proportion in which the cutaneous evaporation is increased. Röhrig has, in the experiment already mentioned, adduced proof of the increased evaporation of water from the skin after a bath. He found that after a warm full bath of 96·8° the yield of water from the skin of an arm was increased

to nearly double the normal amount. No doubt a portion of this increase may be ascribed to the imbibition of water by the most superficial layers of the epidermis, and also to minute quantities of water being retained in the furrows and ridges of the skin. The cleansing of the skin also, and the opening up of numerous closed sweat pores and sebaceous follicles, possibly contribute to facilitate the perspiration. The process may also be assisted in no small degree by the fact that baths, especially hot and skin-stimulating ones, quicken the circulation of the skin by the expansion of its blood vessels, increase the quantity of blood and turgor of the skin, and thus afford favourable conditions for the increase of the cutaneous perspiration.

Daily experience shows that vapour baths and hot dry baths (hot air and hot sand baths), different envelopments of the body, Roman-Irish baths, and sweating baths may increase very considerably the giving off of water by the skin by the mode of perspiration. The loss by perspiration may in a vapour bath of half an hour's duration amount to from 500 to 800 grammes. If the sweating induced by vapour baths be kept up and increased by the heat of the bed after it, the loss by perspiration can easily reach 3 to 5 pounds in 2 or 3 hours. (Most of the literature on this subject is to be found in Lersch, 'Fundamente d. prakt. Balneologie,' p. 232 ff. Compare also Röhrig, 'Physiologie der Haut,' p. 47 ff.)

19. *The excretion of carbonic acid by the skin (a trifling amount certainly) continues in a bath, while the evaporation of water from the immersed portion of the body is stopped. After a bath the amount of both excretions is increased. The evaporation of water appears to be especially abundant after warm and skin-stimulating baths. While the increase of the cutaneous excretion of carbonic acid is quite unimportant, the increased yield of water after a bath may distinctly favour the parting with heat. Hot vapour and dry baths are able to draw very considerable amounts of water from the body by the way of perspiration.*

There are innumerable and often contradictory experiments on the influence of different kinds of baths on the urine, the quantity of it passed, its specific gravity, and its constituents.

As to the amount of water passed after the bath, numerous experiments were formerly made regarding it, under the

notion of thus calculating the amount of absorption of water in the bath.

20. *Directly or shortly after the bath, the cold as well as the warm one, the flow of urine is often temporarily increased, without the whole flow of urine within the 24 hours being influenced observably. The specific gravity of the urine passed after a bath is often a little less, but it is higher after hot baths, which increase the secretion of urea. Sweating baths occasion a diminished diuresis, with stronger concentration of the urine. It has not been proved, and it is not probable, that in this respect mineralised or gaseous baths operate differently from those of simple water.*

It would lead us too far, and would be needless, to name here the numerous observers who have made experiments regarding the behaviour of the excretion of urine after baths of different sorts. Homolle, Merbach, L. Lehmann, Neubauer and Genth, Valentiner, Niebergall, Alfter, Clemens, H. Nasse, Waller, Willemin, Röhrig, and others observed, as the direct effect of various baths, an increase of diuresis, usually of urine of lighter specific gravity. Falk and Kletzinsky disputed those assumptions. Beneke too found that after a bath in the North Sea less urine was secreted. Berthold and Seiche found in baths of 99·5° and more, a decrease, in baths of 96·8°, an increase of the quantity of urine, and others also admit that the increase of diuresis is particularly sensible after cold baths. The experiments of Koloman Müller agree with these observations; he determined, in shaved dogs, the amount of urine which was emptied directly from the ureters (from each separately). Müller applied a special registering apparatus, which made it possible to count the number of drops every 5 minutes. Under the influenee of cold (cold applications, cold showers of water) the secretion of 22 drops in the minute, increased by 5 to 11 drops. The application of heat in the form of eataplasms and pouring water of the temperature of 104°, caused a similar diminution of the amount secreted. Rubbing and stimulating applications had no effect. Very different modes of explanation are current respecting the cause of the increase of diuresis. Formerly it used to be regarded as a strong proof of the water-absorbing power of the skin. In this no one nowadays believes. Others thought that the diuresis was vicarious, and was the consequence of the loss of water through the skin being stopped in the bath. Simple calculation shows that any increase of secretion of urine caused thereby, must be quite inappreciable. Some have appealed with more cause

to the nervous system, and have considered the increased activity of the kidneys to be caused reflexly by the stimulus of the bath. Many believe that skin-stimulating baths containing salts or gas in quantity, work as diuretics, of which there as yet exists no proof. Others again believe that the call to make water is increased after the bath, only by reflex increase of the innervation of the *detrusor vesicæ.* This last explanation does not take into account the increased amount of urine. Finally, some call in the greater blood pressure, which is induced specially by the cold bath, and think that it causes the increased amount of urine. Again, others assume that the contraction of the vessels of the periphery in a cold bath causes an expansion of the blood vessels in the interior and in the kidneys, and that the increased circulation in the kidneys augments the amount of their secretion. I need not enter now into a critical examination of all these opinions, and the less so, because experiments up to the present date have by no means placed beyond doubt the increase of diuresis in cold, warm, gas, and mineral water baths. As I have no experiments of my own on this subject at my command, I have merely followed the opinion of the majority in formulating Proposition 20.

It is still a widely spread opinion, that the urine passed after protracted warm and also after cold baths, is distinguished by a smaller amount of acid, that its reaction is often neutral, or even alkaline. Braconnot's (1833) views to this effect were confirmed by Homolle, Willemin, Amussat, Stöcker, and Zülzer. According to the view of the last three, urine after baths of from 87·8° to 95°, whether they were of distilled water or contained alkalies or acids, lost its acidity the more, the longer the duration of the bath was, or if it was renewed at short intervals. According to Amussat also the alkalescence was the greater, the longer and the warmer the bath was. Since a weighty clinical authority has accepted the assumption of the alkaline reaction of urine, after frequent and long-repeated warm baths, the opinion has been pretty widely received. Nevertheless its accuracy is far from having been proved ; it is indeed very doubtful. Some experiments of mine, which shall be detailed in another place, have taught me, that the acidity of the urine after vapour baths, and also after baths of 96·8° to 98·6°, and of 30 to 45 minutes' duration, either remains the same, or rises or falls very slightly. I also could not detect any decrease of acidity, far less any alkalescence, of the urine, in cases of skin affections when the patients were kept for days in lukewarm water of 95° to 96·8°. Röhrig could never discover any alkaline reaction of the urine after baths continued for hours or after hot sweating baths. Salt baths gave just as negative results, as to which Murray Thomson had already shown that they never occasioned

an alkaline reaction of the urine. I therefore do not consider it necessary to enter on the attempted explanations of this diminished acidity. I may mention only as a curiosity, that some have attributed it to an increased secretion of the 'acids of the sweat.' We know in these days, that the acid matters of the sweat are fatty acids of the decomposed sebaceous secretion, and therefore do not come direct from the blood.

We have no want of assumptions respecting the influence of cold and warm simple baths, and those containing different salts and gases, on the amount of the excretion of urea, uric acid, chlorides, phosphoric acid, &c. The little that is certain, which we know, as to the influence of baths on the excretion of urea, has already been detailed. If we examine further what in addition is known on the influence of different baths on the amount of the excretion of the normal constituents of urine, we arrive at the conclusion, that although attempts have been repeatedly made to solve this difficult question (by Becquerel and De Laurès, Neubauer and Genth, Walter, Clemens, Alfter, L. Lehmann, and many others), yet the investigations up to the present time have been conducted after so defective methods, and fulfil so little the conditions necessary for exact experiments on change of tissue, that their results do not afford adequate proofs of any kind.

We conclude this chapter with a proposition summing up what we have said above.

21. *The assumption that the urine takes on an alkaline reaction after long-continued warm baths of simple water, or of water mineralised as one pleases, is not proved, and is doubtful. Apart from the increase of urea, which is produced by the use of warm baths which raise the temperature of the body, we do not know with certainty of any influence of baths, whether cold or warm, whether simple or containing salts or gases, on the amount of the excretion of the individual constituents of the urine.*

3. Influence of Baths on the Circulation and the Respiration.[1]

It is self-evident that cold and warm baths influence the distribution of the blood in the body (in the periphery and in the

[1] The literature of this is given above, pp. 255–56.

interior), the contraction or expansion of blood vessels, the blood pressure, and the frequency and energy of the contractions of the heart. The mode and the extent of this influence is only in small part known to us, and still smaller is our amount of knowledge of the therapeutic effects to be obtained in this way.

22. *A considerable contraction of the vessels of the skin occurs in a cold bath.*

This is one of the most important protective laws against excessive increase of the parting with heat, and the cooling down of the interior. We have already shown that this protection is not adequate alone, to preserve the constancy of the temperature of the interior throughout the duration of a bath.

23. *The peripheral contraction of vessels is greatest at the commencement of a cold bath, and remits somewhat in the course of it.*

In the case of unusually long duration or of excessive cold of the bath, relaxation of the vessels succeeds their over-stimulation, and the quick sinking of the heat of the interior of the body is the consequence of this. The bluish red colour which the skin assumes after unusually long baths, and also after cold ones, indicates a retardation of the circulation, with a simultaneous expansion of the peripheral vessels, and is explicable by an expansion of the capillaries, while the arterial twigs leading to them, and the venous ones leading from them, are still in a state of contraction. The bluish red colour of the skin under these circumstances, may also perhaps be caused by the tone of the vessels having fallen off; for the expansion of the vessels, simply considered, quickens the circulation only if their tone continues to keep up, if the rhythmical waves of contraction, which promote the circulation, continue and assist the circulation.

As respects the cause of the contraction of vessels under the operation of cold, it is partly the direct influence of cold on the vessels of the skin (arteries, capillaries, and veins), partly a reflex influence, inasmuch as the stimulation of the sensory nerves by cold, is transmitted through the medium of the nervous centre of the vessels by the vaso-constrictors to the smallest cutaneous arteries.

24. *A bath hotter than the skin produces an expansion of the cutaneous vessels, which is recognised in the increased redness and turgescence of the skin. The relaxation of the vessels in a warm bath often lasts several hours after the bath is over.*

Many are of opinion that the alterations in the peripheral circulation induced by the stimulus of cold or of heat, may be increased or modified by the skin-stimulating substances (salts and gases) which are simultaneously present in the baths. But in a cold bath the thermal stimulus supersedes everything else so completely, that the operation on the vessels is defined solely by the degree of cold and by the duration of the bath. If the salts and gases of a bath were in a position to operate like the stimulus of cold, i.e. to excite contractions of the vessels of the skin, then we should have to observe the interesting phenomenon, that the skin would present the same appearance in an indifferent warm salt or gas bath as in a cold one, which is not the case. If the salt and gas contents of a cold bath were early to induce an 'over-excitement' with relaxation of the cutaneous vessels, then the course of the giving off of heat, of the temperature of the body in a cold salt bath, must be essentially different from what it is in a simple water bath of equivalent temperature; but observation speaks against this (compare p. 265). On the other hand the gas or salt constituents of baths appear not to be without some influence on the expansion of the peripheral vessels, inasmuch as such baths often elicit a much greater redness of the skin (expansion of the capillaries), than is usually observed with baths of plain water.

25. *The vessel-expanding after-operation of cold baths, and the vessel-expanding operation of warm baths, appear to be increased by the saline and gaseous contents of the bath.*

We have an unusually large number of observations respecting the behaviour of the heart's action and of the pulse in baths of various temperatures (half, full, sitz, vapour baths, douches, &c.) We need not wonder if the results turn out often to be contradictory, when we consider that the frequency of the contractions of the heart is determined by psychical influences, by the state of attention, by bodily movement, by frequency and depth of the respiration, by the internal temperature, by the individual irritability, &c., and varies within pretty wide ranges. The alterations of the frequency of the pulse, observed in cold and warm baths, lie within those ranges, and a careful observer will often not be able to say, in investigations of this kind, whether the small alterations of the beat of the pulse which have been noticed, are attributable to the bath or to other circumstances.

26. *The greatest number of observers are of the opinion*

that the cold bath usually produces a retardation of the contractions of the heart.

Without going into details regarding the often very imperfect experiments made on this subject, I merely point out that Brauss, Rostan, Marteau, L. Lehmann, Johnson, Petri, James, Lampe, Lilienthal, Diemer, Weisskopf, Fleury, Sieveling, Jones and Dickinson, Beneke, Braun, Minnich, Jakob Marcard, Schmelkes, Pleniger, have observed a lowering of the pulse frequency in cool and in cold baths (full bath, half-bath, sitz bath). Others, as Dauvergne, Niebergall, Duriau, Debey, Böcker, have found the first action of a cold bath to be an increase of the pulse frequency, of longer or shorter duration, which is followed by a gradual retardation, when the pulse falls even below the normal standard. Kirejeff could not detect any effect on the pulse frequency in a sitz bath of from 71·6° to 75·2°. Kernig found regularly, in baths of 95°, a diminution of beats in the course of the bath. According to Beneke a warm brine bath of 87·8° to 89·6° causes an immediate sinking of the number of beats, which is followed by a long increase of frequency after the bath, which often lasts half a day.[1]

While, therefore, there is almost universal consent respecting the gradual retardation of the pulse in a cold bath, opinions differ respecting the behaviour of the pulse at the commencement of the application of cold. It is very obvious, but is not always remembered, that in this the shock of the cold psychically and the preceding movement (stepping into the bath, &c.) exercise an influence on the frequency of the pulse.

27. *The frequency of the pulse is increased, in correspondence with the increased temperature of the body, in baths of the temperature of the skin, which induce a gradual rise of the temperature of the body, as well as in hot baths* (vapour baths, &c.)

[1] We find, as early as Galen, notices of the most important alterations of the pulse by cold and warm baths. 'Balneæ calidæ, dum sint moderatæ, pulsus ercant magnos, celeres, crebros et paulo vehementiores. Immodicæ parvos et languidos, tamen adhuc celeres et crebros. Quod si hic relinquantur, parvos, languidos, tardos atque raros. . . . Frigidæ balneæ illico parvos atque languidiores et tardos rarosque pulsus efficiunt. Postea prout id sic induxerunt: omnino vel torporem inducent vel robur. Quæ torporem intulerunt et refrigerarunt, parvos et languidiores et tardos rarosque efficiunt. Quæ excalefecerunt, et robur conciliarunt, magnos, vehementes, celeritate et crebritate moderatos' (III. *De Caus. Puls.*) Quoted from Lersch, loc. cit. p. 156.

Almost all observers have arrived unanimously at this conclusion, as Ch. Hunter, Londe, Schmelkes, Kernig, Lamotte, Gerdy, Parr, G. H. Richter, Berthold and Seiche, Poitivin, Marteau, Frey, and many others. We call attention particularly to the observations of Kernig, that careful investigator. If he kept the bath constantly at the temperature of the axilla, an increase of the pulse from 80 up to 96 beats took place, along with an increase of temperature from 98·7° to 100·6°; a cold shower of water then caused a rapid sinking of the pulse to 72 to 76 beats.

28. *There is no perceptible influence on the beats of the heart, and no effect worth mentioning on the distribution of blood in the body, from the use of thermal indifferent baths, to which class most of those applied in balneotherapy belong.*

We could scarcely expect any alteration in the distribution of the blood from the mechanical pressure on the portions of the body immersed, which we shall have afterwards to notice.

29. *On the other hand thermally indifferent baths, containing salts and gas, may, by their stimulations of the skin, act like mild epispastics, and occasion a slight expansion of the vessels of the periphery* (hyperæmia of the skin).

Opinions respecting the after effects of cold and hot baths on the frequency of the pulse differ extremely. It is probable that there exists a law of compensation for this condition also, because an alteration of the pulse in an opposite direction usually succeeds, a little time after the bath, to the increased or diminished pulse frequency in warm or cold baths. It need scarcely be said, that this compensatory operation may be checked, or may be made unobservable, by other circumstances which influence the frequency of the pulse in the opposite direction (rest, bodily exercise, taking nourishment, mental activity, hour of the day, &c.)

Some observers are inclined to extend the period of the alterations of the pulse to many hours after the bath. Thus Beneke believes that the pulse frequency after a salt gaseous bath of 87·8°, taken in the morning, remains distinctly increased even till midnight. Berthold and Seiche conclude, that the pulse frequency induced by warm baths, does not subside to its normal state till 4 to 7 hours after. Duriau thinks that he has regularly observed an increase of pulse frequency even a day after the hot bath. On the other side there are numerous observations which would prove, that the altered frequency of the pulse in cold or warm baths, is changed in the other direction after them.

30. *The reflex contraction of the numerous arteries of the skin in a cold bath is followed by an increase of blood pressure, not only in the circuit of vessels concerned, but also by an increase of blood pressure in the other arteries, provided the latter maintain their tone. This increase of pressure reacts, as a stimulus to the left ventricle, and causes at first an increase of the number and strength of the heart's contractions.*[1]

Conversely, the expansion of all the cutaneous blood vessels in a hot full bath (vapour bath), or also after a protracted cold bath, is followed by a reduction of the mean blood pressure, if this process is not at the same time supported by an increased tone of the circle of vessels shut out from the expansion, or by an increase of the energy of the heart contractions. It is entirely erroneous to assume, as is so often done, that the blood pressure is also increased, whenever contractions occur in an extended circle of vessels, from the stimulation of sensory nerves. Influences of this kind, which increase the blood pressure, may be entirely compensated by a tone of vessel that diminishes the pressure, and also by simultaneous alterations in the energy of the heart contractions.

Some further concluded, 'as every stimulation of the cutaneous sensory nerves, whether of chemical, mechanical, electrical, or thermal nature, calls forth the same operation on the circulation, on the blood pressure, &c., and as the difference of result depends solely on the intensity of the stimulus,' that a cold and hot bath, a local and a full bath, a simple, or a salt, or a gaseous bath were all alike in their action on the cutaneous nerves, and as a consequence on the circulation depending on the nervous system. It was also thought that no difference was to be detected, whether the stimulus acted on any fixed portion of the skin or, as in physiological experiments, directly on the laid-bare nerve.

But a closer attention to what the experiments of physiologists have taught, respecting the influence of the sensory nerves on the vessels and the blood pressure, ought to have suggested caution ; for we see that the results of similar stimulation of different nerves are by no means always uniform.

[1] Compare Proposition 26, above.

Grützner and Heidenhain showed, besides this, that different kinds of skin stimulation have very different effects on the arterial blood pressure. Electrical and chemical stimulation, also cauterising the skin, were often not followed by rise of the blood pressure, while a very distinct increase of it was observed after slightly touching or blowing on a portion of skin. Painful stimulations (such as those which Röhrig almost always made use of in his experiments on rabbits) appear to act quite differently on the vasomotors, from tactile excitement of the cutaneous nerves. Latschenberger and Deahna found that stimulation of uniform strength of the *sciatic*, often repeated with interruptions, although it at first increased the blood pressure, afterwards had the opposite effect. The results of experiments with electrical stimulation on the nerves of sensation are equally discordant. It is well known that V. Bezold was the first to prove that the stimulation of sensory nerves, as well as of the skin, produced augmentation of blood pressure, with increase of the frequency of the heart's beats. In this it remained a question, whether that increase was not solely occasioned by the augmented blood pressure. Lovén observed, on stimulating sensory nerves (*N. auricularis, N. dorsalis pedis*), a diminution of the pulse frequency, increase of blood-pressure, and contraction of the arteries. Asp, on the other hand, found, on stimulating sensory nerves (*sciaticus*), an increase of the frequency of the heart's beats. Hering and Kratschmer observed, on stimulating the *trigeminus*, a great retardation of the pulsations of the heart, with little or no increase of blood pressure.

Besides this, Snellen and Lovén showed that the stimulation of sensory nerves sometimes at once produced reflex dilatation of the arteries. The existence of these vessel-dilating (depressor) nerves was proved by the researches of Eckhard, Schiff, Vulpian, and Goltz. Ostroumoff showed that, in electrical stimulations of the *sciatic*, a part of the vessels (those of the abdomen) contract distinctly, by which increase of blood pressure, and of the energy of the heart's contractions, is produced, while, at the same time, the cutaneous circulation is increased by the active expansion of the vessels of the skin. The depression of the temperature of the interior, on stimulat-

ing sensory nerves, which was discovered by Heidenhain, depends on this.

Oswald Naumann was one of the first (1863) to show that stimulation of the skin has an important influence on the heart and the activity of the blood vessels. He found that relatively weak (electrical) stimulations of the skin produce contraction of the vessels, and strengthen the heart's contractions, 'ameliorate the circulation,' while strong stimulations have exactly the opposite operation in these three respects. Naumann was the first who proved in man, by the *pulsmanometer* constructed by him, that electrical and other stimulations of the skin at first increase the frequency and the height of the pulse, but afterwards reduce them. Röhrig has made an immense number of experiments on the behaviour of the heart's action on stimulation of the sensory cutaneous nerves. Confirming Naumann's results, he found that even slight stimulations of the skin (they consisted of dipping the ears of rabbits in spirits of mustard, of cutaneous faradisation with weak currents, of the application of pieces of ice to their ears, &c.) induce a contraction of the small cutaneous arteries, along with an increase of blood pressure; that, as a consequence of this, owing to the increase of resistance, the heart is excited to accelerated pulsation, but at the same time (in this differing from Naumann) the energy of the heart's contractions is diminished. Strong stimulations, on the other hand (as smearing the ears of the rabbits with oil of mustard, strong faradisation), produce at once, in consequence of the reflex stimulation of the *vagus*, as Röhrig believes, a considerable reduction of the frequency of the pulse, at the same time (here too disagreeing with Naumann) a distinct diminution of the energy of the heart's contractions. Winternitz, who applied the graphic method to determine the frequency of the beats of the heart, observed an acceleration of the heart's action always to follow the application of ice to the nape of the neck. 'If the cold was kept applied for a long time, or soon after its operation for a short time, the number of heart contractions was reduced.' The degree and the duration of the increased frequency of the heart's action differ, according to the sensibility to stimulation of the person experimented on.

In the cold baths which are used in balneotherapy, no doubt, only the reflex action of the pressure (at all events at the commencement of the bath) affects the peripheral vessels, which action proceeds with contraction of the vessels, increase of blood pressure, augmentation of the frequency of the heart's pulsations. But the last phenomenon soon falls into the background, and makes place for a retardation of the pulse. This occurs at a time when the temperature of the interior of the body has not yet sunk much, and therefore cannot be occasioned by the influence of the colder blood on the ganglia of the heart, as was once assumed.

31. *It remains undecided whether the 'cutaneous stimulation,' which mineral baths supply, by means of their salt or gaseous contents, to the nerves of the skin, is sufficient to excite reflexly the centre of the vasomotors and of the vagus, and to influence the distribution of the blood and the frequency of the heart's pulsation.*

At all events, too much importance must not be ascribed to this influence. The marked redness of the skin, which is observed after long mineral water baths of indifferent temperature, would indicate a vessel-dilating influence of the salts and gases held in solution by the waters. The question whether there is here a primary excitement of the *vaso-depressor* centre, or whether it is preceded by a reflex action on the *vaso-pressors*, cannot be answered.

The contraction of the vessels circulating in the periphery under the influence of cold, local or general, manifests itself, as is well known, in the superficially lying arteries, by their pulse becoming smaller and often even disappearing. Reversely the pulse becomes fuller, larger, and the volume greater, in a hot bath. Sphygmographically the vessel-contracting effect of cold manifests itself in a shortening of the up stroke, in a distinct diminution of the secondary wave, also sometimes in increased plainness of the oscillations due to elasticity, phenomena which point to increased vessel-tension. The sphygmographical picture, of the dilatation of the arteries in a hot bath, is the reverse of this. It is marked by a long and steep systolic rise, by an increase of the force and depth of the back stroke, when there is an approach of the pulse to dicrotism.

G. v. Liebig examined sphygmographically the pulse ½ an hour to 1½ hour after a lukewarm bath of 96°, of 30 minutes' duration, and

found a flattening of the apex and a disappearance (!) of the secondary wave, and he explains this by the contraction of the vessels of the small arteries, following the bath.

The contraction of peripheral vessels in cold, and their dilatation in hot baths, naturally alters the distribution of blood in the body. The vessels lying more internally are dilated in cold, contracted in hot baths. The experiments of Schüler show how prompt this effect is. He saw the vessels of the *pia mater* of rabbits immediately dilate when he covered their bellies with cold compresses; by the application of warm compresses the opposite effect was produced. Full baths had a much more intense action. It is certain that this was not the result of a reflex action on the vessels of the *pia mater* produced by cold, for the following among other reasons, that the stimulation of sensory nerves occasions, as Nothnagel has shown, the contraction of the vessels of the *pia mater*. Winternitz has made many interesting experiments, after the method invented by Mosso, with the help of a *plethysmograph* connected with a writing apparatus. He showed that cold lessens the volume of the arm, heat increases it; that the volume of the arm of the person experimented on increases on his entering a cold sitz bath, and again diminishes on the application of a warm bath.

We cannot declare *a priori* that the changes which take place in the distribution of the blood, in connection with cold and warm (local and general) baths, may not be of use therapeutically. At the same time we are far from following the extravagant conclusions, professing to rest on a 'physiological basis,' which some hydrotherapists have drawn in this direction. Certain practically long-known contra-indications of cold and hot baths arise, from a consideration of what is as yet known of the effects of baths on the circulation. I refer merely to the contra-indication of them in disposition to hæmorrhage of the lungs, stomach, or brain, in aneurisms, in imperfectly compensated deficiencies of the valves, in fatty degeneration of the heart, in consumptive conditions, in cancer, in tuberculosis, excessive anæmia, &c.

It cannot be disputed that the increased or diminished supply of the blood to the skin, which can be produced by baths, may

be therapeutically of use in certain of its diseases, and as little that baths which temporarily render the internal organs relatively anæmic, at the cost of the peripheral surface, may possibly operate favourably in conditions of disease which are accompanied with hyperæmia of the internal organs. The altered distribution of the blood may also sometimes influence favourably the movements of the lymph, the secretions, the finer processes of change of tissue, the absorption and the decomposition of pathological products. But there is no question, that clinical observation must finally pronounce on those therapeutic conclusions which have been drawn from physiology. Whatever it rejects as indifferent, or even as injurious, cannot be accepted merely on physiological grounds. Wherever there is a conflict between physiological and clinical experience, there is always some faulty physiological interpretation, or some defective view of the nature of pathological processes. Many examples of this might be adduced, some of them taken from the domain of hydrotherapy and balneotherapy. When we observe that simple physiological facts are pressed too far, in order to support wide-reaching balneotherapeutic conclusions; that, on the other hand, this or that, not even very exactly observed, case of sickness, which experiences benefit during a bath cure, leads to no less extravagant conclusions respecting the efficacy of the baths that were employed, it would almost appear, as if many specialists in this branch of medicine, had paid far more attention to the study of physiological handbooks, than to clinical self-instruction.

We must guard against over-valuing the effects of baths on the dilatation of vessels, and the distribution of blood, on the frequency of heart contractions, and on the blood pressure. We are warned against this, when we reflect that all these actions are of a transitory nature, that their secondary is often the opposite of their primary action (expansion of the vessels follows contraction, and the reverse), and that numerous other incidents of daily life, such as exercise, nourishment, psychical exertions, change of temperature of the surrounding air, &c., influence the distribution of blood, and the changing action of organs, in like way, and often in as many and powerful ways as cold and warm baths.

In place of many examples I must here content myself with one. We read in a recent work on hydrotherapy, which assumes the credit of specially good physiological foundation, that cold shower douches act advantageously in heart diseases, with muscular insufficiency of the heart and dropsy, because they increase the tension of the aortic system by contraction of the vessels, in consequence of which it is further concluded, that diuresis will be increased and will overcome the dropsy. I need scarcely point out the erroneousness of such an explanation. If, when there is a muscularly insufficient heart, which is not able to overcome the normal obstacles to the circulation (as the dropsy and other signs of a retarded circulation prove), still greater obstacles are presented to it by extensive contraction of the arteries, how can the circulation be in this way accelerated and relieved? There is indeed abundance of obstructions in those cases; it is power to overcome them that is wanting. Further, is arterial contraction synonymous with increase of blood pressure? The latter only occurs in such a case as has been cited, when at the same time the tone in the collateral dilated circle of vessels is kept up, and when the energy of the heart contractions is increased proportionally to the total of the increased resistance.

On the other hand we learn, very recently indeed, that lukewarm or cold baths, and especially salt baths rich in carbonic acid (the author is here pleading like Cicero *pro domo*), are a 'tonic of the first rank for weakened hearts.' The author was in the fortunate position of being able 'to prove in many cases, within a few days, distinct and progressive diminution of the weakened action of a pathologically enlarged heart' by the use of such baths. The brine bath, 'through the operation of the *vagus*, compels the heart to slower and more powerful contractions.' It is furthermore laid down:—

Every greater occasional activity of a muscle produces an increase of substance in it, as in the instance of the muscles of a gymnast, or the muscle of the arm in a smith. Although the bath induces a state of 'general contraction of the vessels,' yet there is no observable increase of blood pressure, and for this reason: 'because the capillaries gain time to cover by their expansion the loss of space, in the same proportion as the larger vessels leading to the muscles suffer by their reflex contraction (!).' In this way, not only is the heart's labour increased, but even lightened (!), in spite of the 'general contraction of vessels.' The salt bath, it is further said, operates like digitalis, which also increases 'the work of the heart and blood vessels,' and strengthens the heart, by producing less frequent and more powerful contractions. 'In this way only is the really tonic operation intelligible which digitalis, after success during temporary treatment,

often leaves behind it for months and years (!).' This is only a specimen, by way of example.

If indifferent warm or cool baths, simple or salt baths, should act favourably on muscle weakness, and on an insufficiently working heart, this may happen, either by their regulating the action, or by a lessening of the resistance, or by an increase of the energy of the heart's contractions. The last effect, some supposed, might be produced by the obstacles of the circulation being increased—for instance, by increased contraction of vessels. That would react as a stimulus on the left ventricle, and would increase the force of its contractions. In this way the heart muscle would be strengthened, like every muscle the activity of which is increased. But what may be quite true of a healthy biceps, does not necessarily apply to the diseased muscle of the heart, with fatty degeneration and altered in its conditions of nutrition and innervation. The result of repeated appeals to a heart, which is not able to overcome even the normal obstructions to the circulation, is a quickly setting in exhaustion, with increasing dilatation. It is different if the cool simple or salt bath is to act as a regulator of the heart's activity, the possibility of which has not yet been shown by any proof. If it were in that way possible to bring a heart, which was arhythmic, and wearing itself out in unusually frequent and fruitless contractions, to a more regular and a slower action, in that case the systole would be prolonged and more yielding, the emptying of the ventricle would be completed, the diastolic pause lengthened, and along with that the removal of the *fatigue products* favoured, and the nutritive condition of the heart's muscles improved. The consequence of this would be an increase of the muscular hypertrophy (already existing indeed, but which had become insufficient), in order to compensate the obstructions. A muscle, it is known, gets sooner wearied, when it raises to the same height a smaller burden in short intervals, than when it raises a heavier one at longer intervals.

It cannot be denied that heart cases with compensated valvular defects, and others with temporary insufficiency of heart (muscular or 'functional' insufficience), may become in a certain sense improved, indeed in case of simple muscular insufficiency may be actually cured at the most different baths, as also at climatic stations, under the operation of the favourable factors of a cure life.

With respect to the influence of baths on the respiration, the most important question, which we have already considered in passing, is that regarding the relations of the excretion of carbonic acid. It will therefore be enough to describe briefly the influence which baths exercise on the frequency and depth of the respiration.

It is well known that on stepping into a cold bath, or when we are subjected to cold affusion, we have, along with the feeling of 'shiver,' a feeling also of difficulty of breathing. The first effect of the sudden and unexpected application of cold to us, and also of other intense or painful stimulation of the skin, is the drawing of a long inspiration, which, if accompanied by pain, may deepen into an inspiratory sigh. At the height of this sudden and deep inspiration, there occurs a momentary pause of respiration, with closure of the glottis for a very short time, when it uncloses again ; then follows a long-drawn expiration, when there is pain, often amounting to a groan. In children we have, instead of this, another expiratory act, that of crying, which is interrupted by occasional short, although deep, inspirations. The often over-praised favourable effects of cold affusion, in overcoming collapse and *atelektasis*, are frequently rendered nugatory by this. The much longer lasting forced movements of expiration in crying, destroy generally the good effects of the deeper inspirations, as the cyanotic look of children after such processes shows us.

The just described operation of the stimulus of cold does not always set in exactly in the same way. The momentary stimulation of cold does not always produce a deep inspiration : it sometimes simply impedes the breathing, and this according to the stage in which it finds the act of respiration ; in other cases it does not merely act as impeding the respiration, but it causes a pause in the expiration, usually at the same time with closure of the glottis. The stimulus of cold may, therefore, also have a reflex expiratory action, like other stimulants of sensory nerves ; I refer only to laughing when the feet are tickled, to crying on sudden pain, to sneezing on stimulation of the sensory twigs of the *trigeminus*, to coughing on irritating the mucous membrane of the respiratory tract.

Falk studied in rabbits the effect of suddenly dipping them under water. He observed on this a pause in breathing, and indeed in the expiration when the animals were dipped at the period of expiration. If the dipping was performed at the commencement of the inspiration, it, as well as the next expiration, proceeded normally. Then a period of rest set in. These phenomena were also seen in rabbits, which had been placed under the influence of morphia; so

were not occasioned by psychical excitement. It was seen at the same time that the portion of skin which is wetted is not a matter of indifference. Wetting the walls of the chest acted most powerfully. The water could, as Falk believes, have acted here only as a mechanical stimulant, because cold water and water of the temperature of the blood, both produced like results. Schiff observed that mechanical pressure on certain portions of the skin, on the cutaneous nerves of the ear, the neck, or the chest, lowered the frequency of the respiration of the animals experimented on; suspension of breathing occurred in place of expiration.

According to Röhrig, all skin stimulants act alike on the respiration, and retard it. When he covered up narcotised rabbits in a water cushion filled with iced water, great dyspnœa first set in, followed by a gradual diminution of the frequency of respiration. If Röhrig smeared the inside and outside surface of the muscles of the ear with croton oil, cantharides oil, spirits of turpentine (which Röhrig regards as mild stimulation), then retardation of respiration set in. The same happened after more severe stimulants, but more intensely. Röhrig, as we have said, is inclined to attribute retardation of the breathing to all kinds and strengths of skin stimulation.

My own experiments on the volume of air expired under different circumstances show, that there is no such rule universally true. When I suddenly moved a rabbit from a temperature of 53·6° to one of 0·5°, it appeared, in this bath of cold air, that the energetic application of cold to the skin caused a considerable increase of the frequency of the respirations. The volumes of the breath rose to more than double, and indeed the depth of the acts of respiration was increased even more than their frequency. In another experiment the frequency of the respiration remained almost the same, while the depth of it, measured by volumes, increased distinctly. These facts, being in contradiction with the results of later observers, induced me to subject to a new examination the question how cold, and especially cold baths, act on the frequency and on the depth of respiration. Those experiments will be detailed at length in another place. In one case an incipient retardation of the respiration showed itself on immersing a rabbit in water of 53·6° temperature. After 10 minutes a slight increase of the frequency of the acts of respiration was observed. The volume of breath was increased about 25 per cent. during the bath of 15 minutes.

If the stimulus of cold is long continued, as in a cold bath, an acceleration of the acts of respiration, with visible increase of their depth, in many cases succeeds the initial deepening and

retardation of the acts of respiration and the dyspnœa of the shock of cold. But, according to my observation, there is not always uniformity in this. In other cases no variation, or even a slight diminution of the number of acts of inspiration, was observed, accompanied by a deepening of the acts.

32. *All observations agree that the amount of air respired* (measured according to volumes) *increases in the cold bath. This result is produced sometimes by the deepening of the acts of respiration, while their frequency remains the same, or is even somewhat retarded, sometimes by increase of the depth and frequency of the acts of respiration.*

The accounts given of the behaviour of respiration in cold baths are very different. Johnson observed in many experiments with cold baths an increase of the frequency of respiration; Lilienthal observed the same in cold sitz baths. According to Duriau a cold bath retards the respiration. Sachse again, and Virchow also, found the respiration accelerated in a cold sea bath. According to Dauvergne the respiration is at first quick and short, later deep and slow. Vierordt was the first to show that the number of respirations in cold air, in which the impression of cold on the mucous respiratory surfaces has to be considered, is somewhat greater than in warm; my experiments on rabbits, mentioned above, showed the same. If the intense operation of cold lasts a long time, an increasing retardation of the act of respiration occurs. This is especially the case (along with gradual diminution of depth) when the temperature of the body of the animal experimented on is considerably reduced.

L. Lehmann observed in sitz baths of the temperature of 95° to 96·8°, also in warm thermal and in ordinary baths of 82·4°, a diminution of the number of the acts of respiration, a phenomenon which begins slightly during the bath, and which reaches its highest point an hour after the bath, always presupposing that the body has been kept in a state of rest.

While the alteration of the respiration (in frequency and depth), at the beginning of a bath, is undoubtedly dependent on the stimulus of cold to the sensory nerves of the skin, the increase of the volume of the breath in the course of a cold bath is chiefly to be referred to the increased generation of carbonic acid. Very different views had been formerly entertained respecting the connection of the phenomena. Inasmuch as the

quantity of carbonic acid given out in a certain time varies to a very considerable extent, according to alterations of the frequency and depth of respiration, as the experiments of Vierordt, Lossen, Berg, C. Speck teach, it was further concluded that the increased excretion of carbonic acid in a cold bath was occasioned entirely and solely by the increase of the volume of respiration. L. Lehmann, for instance, still thinks that he can draw such an inference from his experiments. According to him, we have not to do with an increase of the production of carbonic acid in a cold bath, but with an increased excretion of the carbonic acid, normally formed and present in the body, which is called forth by the increase of respiration. The error of this view is apparent when we take into consideration the circumstances of the parting with, and the production of, heat in a cold bath, and the considerable increase of the same, along with the circumstances of the carbonic acid. In addition to this, Liebermeister has proved, by experiments and by calculation, that intentional increase of the movements of respiration cannot increase the temperature of the body. It is also difficult to reconcile with Lehmann's assumption the fact, that the excretion of carbonic acid goes on increasing for a little time after the cold bath, and only gradually returns to the condition before the cold bath, or to one lower than it, while the cause of the altered volume of breath is removed with the cessation of the stimulus of cold.

The question may be asked, on the other side, whether the increase of the volume of breath in the cold bath is not the cause of an increased supply of oxygen, and of combustion in the body. Since the researches of Voit, Pflüger and his scholars, it has been pretty generally accepted that the cold induces the increase of the carbonic acid, not exclusively by increased respiratory movements (a small amount of the increased production of carbonic acid must be set down to the account of the increased activity of the muscles of respiration). It was Voit especially who long ago, by his researches in change of tissue, had arrived at the conclusion that the movements of respiration do not determine the amount of the consumption of oxygen and of combustion in the animal body, that rather, on the contrary, the respiratory movements are determined and regulated by the

consumption of oxygen in the tissues, and by the amount of the combustion in the body.

33. *Nothing is known of any alteration of the frequency or the depth of respiration in indifferent warm baths. The frequency of respiration is in baths of and above the temperature of the skin (especially in vapour baths) increased, proportionally to the increase of the temperature of the body and of the production of carbonic acid.*

Most observers agree that the frequency of respiration is in a marked degree increased in warm damp air, and still more in vapour baths (Gerdy, Ritter). The same was observed in warm and hot baths, and in such as raised the temperature of the body (Schmelkes and Seiche, Frey). Wiegand and Marcard alone found the reverse—namely, a retardation of the respiration in vapour baths and warm baths. Kirejeff observed no alteration of the frequency of respiration in warm and hot baths. Lersch thinks that there is an acceleration of respiration, even when the lungs are excluded from the vapour of baths, as in some vapour box baths. The respiration in hot dry air baths appears to be different from that just described in hot vapour and moist air baths. Hunter observed in it oppression of the chest, which led to diminished frequency of respiration. Oesterlen found the number of respirations in the person with whom he experimented, in a chamber heated up to 143·6°, remain normal. Fordyce and Tillet said the same. The results of Magendie's experiments are in contradiction to this. He observed greatly accelerated respiration occur in dogs, in rabbits, and in Guinea-pigs when he shut them up in heated boxes. My experiments with rabbits agree with his. These creatures, when brought into dry warm and hot air, immediately showed increased frequency of their respiration : the volume of the air expired increased. But when there was excessive frequency of the respirations, their depth fell so considerably that the amount of breath (measured by volume) became considerably smaller.

34. *The stimulation which mineral baths exercise on the skin nerves, by the salt and gas which they contain, is not in a position to influence the frequency or the depth of respirations.*

4. Influence of Baths on the Nervous System.

We have repeatedly in passing, while discussing the influence of baths on the regulation of heat, the change of tissue,

the expansion or contraction of vessels, the pulse frequency, and the mechanism of respiration, referred to the sensory nerves of the skin, as the organs the thermal and mechanical stimulation of which produces the influences just mentioned.

The cold and warm bath also acts no less powerfully on different functions of the central nervous system. Our daily increasing knowledge of the influence of the peripheral nervous system on the most complicated processes of the organism, (I mean the phenomena of magnet and metal therapeutics of *transfert*, the wonderful observations on hypnotised subjects), allows us to conjecture that the stimulation of the skin, produced by various simple or salt and gas containing baths, even when it is far below the measurement of ordinary sensation, may influence the central nervous system and the organic functions under its rule. Some of these influences are known.

35. *Their influence on certain common sensations, and on the activity of the brain, are among the operations of cold and warm baths that can be proved subjectively.*

Experience has long taught us effects of the bath which can be therapeutically applied with distinct purpose. The sprinkling with cold water of persons who have fainted, or are apparently dead, excites not only the respiration, but the psychical functions also, and accelerates the return of consciousness. In many cases of coma, as in typhoid, in meningitis, in stupor of insane persons, cold affusion operates similarly.

36. *A cold bath of short duration* (cold douche and affusion) *acts, as 'vivifying' and refreshing, produces a sense of feeling well, a certain degree of impulse to muscular action, and a certain lightness and satisfaction in carrying it out.*

These operations of cold, which everyone has experienced in his own person, are, no doubt, to a certain extent muscular sensations, which at present cannot be completely explained. The cold bath has the same enlivening influence on the mental activity, the psychical power of work, and the desire for intellectual labour. But all these influences of cold are by no means certain or to be determined beforehand. The opposite may occur. When we are wearied by mental or bodily activity, when the number of dissociable molecules, and so the sum of our stored-up tension,

is sunk by previous labour below a certain point, then cold can only act for a moment as a stimulant; but this effect is of a passing nature, and leaves behind a greater diminution of the dissociable molecules, a feeling of weariness and of depression of mental and corporeal powers. Rest and nourishment are necessary to restore the dissociated molecules. In the same way, an unusually protracted bath operates as tiring, and inducing to sleep, and has, as its consequence, a lowering of the bodily temperature, a long-lasting increase of heat production, and an increased conversion of nitrogenous substances.

37. *Prolonged warm baths, hot and vapour baths* (all of which, it is known, increase the temperature of the body, the frequency of the pulse and respiration, the excretion of carbonic acid, and the conversion of substances rich in nitrogen) *usually act as relaxing, tiring, and causing sleep.*

Of this operation also it must be said that it is by no means uniform. The very opposite of the expected result may occur. Thus warm baths in the evening, a short time before going to bed, although they are wearying to me, yet prevent my falling asleep, and disturb my sleep. Everyone who has made experiments with patients in bath procedures will admit, that individual relations here play an important part, that the operation of the bath on one and the same individual is not always the same, or rather that it is different at different hours of the day, and also different at the same hour on different days. It is not quite decided how the bath comes to have this tiring, sleep-inducing influence. Increased change of tissue in the muscles, increase of bodily temperature, the accumulating in the system of the *fatigue products*,[1] may be taken into account. One is also involuntarily reminded of the experiments of Charcot and of others, which induced sleep by the placing of metals and by the application of magnets on the skin. The slow, monotonous, regular, and repeated stimulation of the cutaneous nerves in hypnotising, induces sleep, impedes and disturbs the interior activity of the greater cerebrum, occasions a heightened

[1] *Ermüdungsstoffe*, the accumulation of certain fatigue products in the muscles, which during their activity are generated in excess, and not quickly enough removed by absorption. They are supposed to be chiefly carbonic acid, and the acids and acid salts of the muscles.—*Tr.*

excitability of the subcortical centres, and makes the man overtaken by sleep, a reflex automaton. All these aids of sleep can here be but cursorily alluded to.

38. *The exciting or depressing influence of cold and warm baths on the activity of the brain, may be sought in a reflex influence on the vessels of the brain, produced by the thermal stimulus of the sensory cutaneous nerves.*

Nothnagel showed that electrical stimulation of the sensory cutaneous nerves produces reflexly contraction of the vessels of the pia mater. This was confirmed by his scholar Krauspe. According to Schüller's researches, application of cold to the skin immediately produces expansion of the vessels of the pia mater, which lasts during the cold bath, and after it, makes way for a contraction or a changing condition of them. Reversely, a warm full bath almost always produces a powerful contraction of the pia mater vessels, which is followed by a 'short' expansion, either during the bath, if it be a protracted one, or after it is over. On the other hand, a cold sponge laid directly on a branch of the cutaneous nerves produces at once contraction of the pia vessels, and on the corresponding side of the brain; while, again, a hot sponge at once produces expansion of the pia vessels on the same side, an observation which is in contradiction to the law of the uniformity of the action of qualitatively different nerve stimulations. Schüller is inclined to consider the expansion of the pia vessels in a cold, and their contraction in a warm bath, as secondary or collateral actions of the alteration of the calibre of the cutaneous vessels by the baths. While cold contracts the peripheral vessels, its further consequence is the expansion of the pia vessels; the action of the warm bath is just the reverse. We may therefore propose the following hypothesis. The long-continued cold bath, as well as the warm and hot bath, occasion a marked relaxation of the peripheral vessels, a relaxation which lasts for a considerable time, as the appearance of the skin after such baths shows. The expansion of the peripheral sphere of circulation occasions secondary anæmia of the brain, and on this depends the wearying and sleep-producing effect of such baths. The stimulating, exciting action of a cold bath of short duration, which shows no after influence on the calibre of the peripheral vessels, may be occasioned by the temporary increase of the amount of blood in the brain, if the removal of the *fatigue products*, the reparation of nutritious matter, and the restoration of the dissociated molecules are favoured by it.

I shall not enter on the discussion of the many objections that

may be taken to such hypotheses, and to their being grounded on experiments on rabbits.

The sleep-producing effect of slight monotonous tactile stimulation can scarcely, as Heidenhain shows, depend on any reflex influence (contraction) of the brain vessels, for Heidenhain was able to throw into a hypnotic state a person (or 'medium'), during the expansion of the vessels of the head under nitrate of amyl.

I need not enter on the hypothesis, that the calming and deadening sensation effect of protracted warm baths, is dependent on the swelling of Krause's terminal nerve knobs, or Meissner's corpuscles of touch-feeling, caused by the imbibition of water, as Heymann and Krebs believe.

39. *Reflex and cramp-like contractions of voluntary and of involuntary muscles can be lessened and removed by warm baths.*

Under this head comes the eminently pain-removing, and often curative, action of prolonged warm baths in cramps and colics of the intestinal canal, in obstructions from gall stones or urinary calculi; in colics of the bladder, kidneys, or uterus; in spasm of the sphincter of the bladder, in strangulations of hernia, and in tetanus. Their operation in such cases may be explained in various ways. Either it is a question of obstruction of reflex action, when the stimulated cutaneous nerves act in obstructing the reflex action, proceeding from the spinal column; or the expansion of the circulating vessels of the periphery, produces secondarily a relative anæmia of the spinal column, and in this way interrupts the reflex act, by lowering the reflex excitability; or there is a direct muscle-tone-lowering influence of heat, on the contractile elements of the muscles, which are involved in the cramp.

40. *Lukewarm baths diminish the excitement of the peripheral ends of the sensory nerves, and thus the excitement of different nerve centres* (Traube).

A stage of feeling of chill sets in, after warm as well as cold baths, which lasts a longer or shorter period, which, experience shows, is best shortened or brought to a close by exercise after cold baths, and by rest and warmth (heat of bed) after warm ones. This chill, which is observed after both hot and cold baths, may depend on an increase of aqueous evaporation after

a bath. According to Traube, it is the relaxation of the cutaneous vessels in a warm bath, which induces the giving off of heat and cooling after it.

41. *The stimulus of cold on the sensory cutaneous nerves, in a cold bath, often excites reflex movements.*

For instance, a cold bath frequently produces evacuations of the bladder and of the bowels in typhus patients, who are in a semicomatose state. This depends on a reflex excitement of the peristaltic action, and of the *detrusor vesicæ*, on excitement of the *ano-spinal* and *vesico-spinal* centres. The application of the catheter in typhus has become less frequent, since the cold water treatment has been introduced, because it acts, not only indirectly by keeping the sensorium free, but also directly by the reflex action of cold on the emptying of the bladder. Movements of the uterus, of the gall ducts, and of the ureters can be excited by cold baths, just as the peristaltic action of the digestive canal, and the action of the bladder. On the other hand, an excitement of the centre of the *nervi erigentes*, along with priapism and voluptuous feeling, often occurs in a warm bath.

The various qualities of sensation of the skin, the sense of touch (measured at the smallest deviation of the points of the compass at which double sensation is recognisable), the feeling of pressure, the fineness of the sense of feeling, and of the sense of temperature, are all altered by hot and cold baths. Experiments hitherto made in this direction, are not sufficiently numerous to warrant positive conclusions. Of all these influences, the best established is the anæsthesiating effect of cold, or of high degrees of heat (Weber). Temporary application of cold, according to Winternitz, heightens the excitability of the sense of touch ; a short application of heat has the same effect. Basch and Dietl, as well as Jakob, found increased cutaneous sensibility after lukewarm baths containing carbonic acid. Santlus arrived at the same result by using salt baths.

J. Stolnikow, in his researches on the alterations of the sensibility of the skin, in the healthy man, by cold and warm baths, came to the conclusion, that warm baths of 101·75° to 106·2°, and of 10 to 20 minutes' duration, make the sense of feeling more acute, while cold baths of 68° to 75° deaden it. The favourable effect in many cases of *pruritus cutaneus* of prolonged warm baths shows, that they can also, under some circumstances, lower the excitability of the cutaneous

nerves. But sometimes, as a case just observed by me shows, cold baths may act much more efficiently in such a case. A patient with chronic icterus, the consequence of permanent closure of the bile duct, had her painful itching of the skin greatly improved by cold baths, when warm ones had failed to give relief.

The influence of baths on the nervous system, and on the organic functions depending on it, is not nearly cleared up, either physiologically or therapeutically, by what has as yet been brought forward (in this and the preceding chapters).

42. *On the contrary, it is probable, that cold and warm baths, by their influence on the nervous system, have various other actions on the economy of the organs, which up to this time are unknown to us. Such action may possibly influence the secretion of various glands* (the salivary glands, the gastric juice, the liver, the pancreas, &c.), *the absorption in the digestive canal, the motion of the lymph, the trophic centres, and through them the more intimate processes of tissue change.* It is possible, that the old well-grounded belief of the absorption-producing power of baths, in exudations of the most different natures and seats, of the action of baths in certain anomalies of nutrition, in anæmias, chronic catarrhs, paralyses, neuralgias, and numerous other chronic complaints, may rest on the foundation of such delicate, but as yet unknown influences.

Indeed, we may in these days even entertain the question, whether baths thermally alike, but chemically different, really have any specific actions, a question which has fallen much into the background since the doctrine of skin absorption has been overthrown. When we see that a few slight strokings of the skin, or passes, can obstruct the interior activity of the brain, and turn the person experimented on into a reflex automaton with no will of his own; when we find that even waves of sound in speech, conveyed by a funnel to definite hypnotised circumferences of skin, cause the person to repeat the sound (a perfectly wonderful and scarcely credible connection between the sensory cutaneous nerves and the centre of sound); when we hear that repeated slow stroking over the skin of the left side of the crown of the head produces aphasia, and further a paralysis-like condition of the extremities, and of the face on the right side, an

entire loss of the sensation of temperature in the paralysed half of the body, and total colour blindness of the right eye; when we find that the aphasia ceases when strokes are made on the right side—these, and many other hypnotic experiments, indicate relations of the sensory cutaneous nerves to the centres of imagination and of sense, which not long ago were not even dreamt of, and were considered by everyone to be impossible, as contradicting certain fundamental laws of physiology (I refer only to the doctrines respecting the organs of construction).

If we add to this the remarkable fact, that certain anæsthesias of the skin may be removed by placing on the skin special pieces of metal, we need not wonder if bath specialists, on the analogy of such phenomena, have of late been proclaiming the specific action of baths containing carbonic acid, soda, lime, sulphur, and iron, that in this they appeal to the clever hypothetic attempts to explain metallotherapy made by Schiff: just as certain metals influence specifically the cutaneous nerves by their specific molecular action, so it is held that the molecular action of the water of the bath increased by the heat, or by the specific movements of the different gas and salt molecules dissolved in it, are the agents which, by their minimal vibrations (far too fine to be appreciated by any means of measurement), set up various forms of movement in the excessively fine terminations of the cutaneous nerves, and through them act on the different centres of the brain and spinal column. In this way various influences, corresponding to those of the metal, may be brought to bear on the tissue change, the blood preparation, the assimilation, the trophic and the secretory processes, according to the difference of the forms of motion which produce the stimulation.

It must be said, in reply to those conclusions, resting on apparent analogies, that the facts of metallotherapy are ascertained, although the theory of them is still hypothetical; that balneotherapy is bound to produce equally absolute facts, respecting the specific action of different kinds of baths, before it is entitled to use hypothetical analogies. But balneotherapy is not in a position to adduce any such facts, to show, for instance, that chloride of sodium baths have a specific power of occasioning absorption, that baths of iron specifically increase the amount

of hæmoglobin, that thermal waters act as specifics in rheumatism and nerve affections, or that sulphur baths trace out latent or slumbering syphilis, or specifically assist in excreting mercury.

5. Electrical Operations of the Bath.

H. Pröll: 'Gastein,' 1st edit., Vienna, 1862, and *Archiv f. Balneolog.*, 1864, iii.—H. Scoutetten: 'De l'Electricité considérée comme Cause princip. de l'Action des Eaux Minérales sur l'Organisme.' Paris, 1864.—Gigot-Suard and Lambron in *Cannstadt. Jahresber.*, 1865, v. 225.—K. Heymann and Krebs: 'Phys. med. Unters. über die Wirkungsweise d. Mineralw.' Wiesbaden, 1870.—Heymann: 'Unters. üb. d. Wirkungsweise d. lauwarm. Süsswasserb. u.s.w.,' *Virchow's Arch.*, vol. l. p. 151 ff.—Hüller: 'Unters. d. Driburg. Quell. auf ihr Geh. an Elektr.,' *Deutsche Klinik*, 1872, No. 50.—Schuster: 'Unters. üb. d. elektr. Verh. d. Thermalw. v. Aachen,' *Archiv d. Heilkunde*, 1873, part i. p. 83.

We must here also mention the operations of electricity, which are often much talked of, and over-valued in modern balneology. To explain the 'wonderful healing powers' of mineral waters, some have neglected the tedious way of induction, of observation, and of experience, have dipped down into the depths of molecular physics, and the physics of the imponderable, and have endeavoured to build up a 'physical balneology' from theories derived from that quarter. The same persons, who ascribe to mineral waters a heat different from the heat of ordinary water, who speak of heat colours, heat tones, heat concert, heat spectrum of mineral waters, as powerful curative agencies in baths, have also assigned an important position in their airy hypotheses to 'electrical bath influences.' The pseudo-physical phrases of some of these writers, need not prevent our considering the careful experiments which some have made with reference to the electrical conditions which may occur during the use of baths. We shall find that our actual knowledge in this direction is very scanty, and by no means justifies the high-flown phrases which were used, now some time ago, concerning the electro-physiological and electro-therapeutic actions of certain mineral waters. Scoutetten has not been the first, but the first with the help of the suitable instruments, and with a suitable mode of investigation, who has made experiments regarding the electrical difference of common and of various mineral waters, and on the electrical tension between the bath water and the portions of the body of the bather that were not immersed. Considering the defective state of our knowledge of the causation of balneotherapeutic curative effects, it is not surprising that Scoutetten's experiments met with an

enthusiastic reception in balneological circles. The wide gulf which still existed between the results of this experiment (which are in themselves not uninteresting), and the curative effects of mineral baths, was bridged over by the imagination ; and some, blinded by the discovery of a new power, blinded by the exact physical proof of it, recklessly agreed with Scoutetten, who promised from his experiments, which were in reality poor in results, 'a complete revolution of the views of physicians on the action of baths.'

Heymann and Krebs conducted a scientific objective examination and repetition of Scoutetten's experiments. Essentially accepting Scoutetten's method, they first examined in a great many experiments the relations of the electrical current, which are observable on inserting in the current circuit of a sensitive galvanometer common distilled and various mineralised waters. They found that all the mineral and gas-containing waters, with the exception of sulphur ones, acted positively when brought in contact with distilled water, that the highest or 1st degree of electrical relation was caused by the presence of the gases suspended in the water (CO_2, N, O, SH_2), the 2nd degree by the temperature (with increase of it, augmentation of the conducting power and diminution of resistance occur), and the 3rd degree by the presence of salts. The gases contained in mineral waters are the cause of their electro-positive behaviour (in SH_2-containing water negative), for distilled water, containing neutral or basic salts, is towards distilled water, not electro-positive, but negative. We must not entirely overlook the possibility, that disturbing elements and sources of error may have been introduced into these experiments by the different temperature of the soldering joint (between the platina plate taking up the current and the conducting wires).

Further, Heymann examined the electrical current which arises on the water of a bath being disturbed by the human body, in which the latter acts as conductor. The one platina plate was dipped in the bath water, while the other was pressed on a portion of the surface of the body outside the bath, and also a platina point was introduced under the skin. In this case common well water showed itself positive, so also did carbonic acid water, but sulphuretted hydrogen water was negative. The bathing tub rested during these experiments on an insulated basis. This is all that we know of the electrical actions of baths. We find, in the body of a man sitting in a bath, a difference of electric tension, just as in a piece of metal dipped in it, its free end acts negatively towards the water. But what is the meaning of this difference of tension between the parts not immersed and the bath water? Some thought that the friction of the water by the body might have called forth electric action ; but the friction going

on all day in ordinary life between the clothes and the body is far more powerful. People forget that the human body is a good conductor, that the bathing tub does not usually stand on an insulated basis, that it cannot be a case of storing up electrical energy in the body, but rather that the electric neutral state is maintained constant. It is possible, although it has not been proved, that a *total current* exists in man, like the frog current. It is possible also, that electromotor powers may be seated in the skin, that differences of electric tension exist between different parts of the skin, that these differences in the unimmersed parts may be converted by the bath water into flowing currents. But what physiological or therapeutic action can currents have, which are so minimal, that they can scarcely be indicated by a multiplier of many thousand coils? If the operation of mineral baths were to depend on their electric action, what an immense aid would they derive from the electrical battery, which is much more easily procured! Heymann thinks, that he is able to deduce the stimulating action of mineral waters from the electric stimulation of the cutaneous nerves. Renz goes much further in this direction, as to the electromotor power and action of mineral baths (notably, very naturally, of his own *Wildbad*). It is unnecessary to enter here on this entirely groundless theory.

43. *The electrical minimal currents, which arise by the contact of different temperatures, and also of the body of the bather with the water, which is usually of different temperature from it, have not, for the present, any practical or theoretical importance.*

The same is true, on the other side, as to the electric currents called in to explain the good effects of waves, of the flesh brush, &c., which are said to be produced by the friction between the body and the water in motion.

The opinion, which was entertained for a long time, that the human body, in stepping into a bath, dipped itself as it were in an electric battery, and was surrounded by innumerable cutaneous minimal currents, is to many minds very attractive. But the electric power is distributed everywhere through nature; the various processes of motion, which make up life, show themselves sometimes in the form of heat, sometimes of bodily exertion, then again as electric activity. All those minimal electric currents, which occur in the functions of the most different organs, remain, like the electricity in a bath, within the domain of physiology, and we must guard against attaching more weight to those theoretically interesting but practically

unimportant processes than they deserve, according to the present state of our knowledge.

6. Mechanical Action of the Bath.

We understand by this, the action which a bath exercises on the bathing body by its mass and weight. The pressure is increased by movement of the bath water, by the strong blow of the waves in a sea bath, and by the impulse of the water in a flowing bath. The mechanical friction of skin in the bath may be artificially increased by stroking, kneading, beating, shampooing, the flesh brush, by rain douches, falling *Sprudel* baths, &c. In all these cases there is a more or less powerful stimulation of the cutaneous nerves. This stimulation is the chief mechanical action of the bath. The movement set up by this, in the terminations of the cutaneous nerves, spreads to the central organs, and may evoke various reactions there, influence the general feeling in the system of tiredness or of refreshment, and the increased or diminished mental or corporeal energy, and excite the centres of the respiration, of the action of the heart, and the vaso-motor, trophic, secretory centres. Little though we can doubt the possibility of such action, still less is known about its *quo modo* and *quantum*. It is quite possible, that some of the therapeutic effects of a bath ought to be ascribed to the mechanical stimulation of the pressure of the water (especially in a sea bath), but our knowledge does not enable us to lay down anything positive concerning it.

44. *In most cases, the mechanical factor of the bath is added to the thermal one, since both operate qualitatively alike, as far as skin stimulation is concerned.*

Calculations as to the amount of pressure, to which the surface of the bather is exposed, are of little importance. Probably 500 to 600 kilogrammes are, in an ordinary bath, added to the atmospheric pressure of 15,450 kilos. on the whole body.

7. The Absorption in a Bath.

The following list of works has of course no pretensions to being complete.

Séguin: *Ann. de Chim.*, 1792, vol. xc.—Lebküchner: 'Dissert. inaug.' Tüb. 1819.—Segalas: *Journ. de Magendie*, 1824.—Madden: 'An Experim. Enquiry into the Phys. of Cutan. Absorpt.' Edinburgh, 1838.—Krause: Art. 'Haut' in *Wagner's Handwörterb. d. Physiologie*, 1844.—Kürchner: Art. 'Resorption,' ibid.—Gerlach: *Müller's Arch.*, 1851.—Falck: *Arch. f.*

phys. Heilk., 1852.—Homolle: *Union Méd.*, 1853.—Alfter: *Deutsch. Klin.*, 1853.—Kletzinsky: *Wien. med. Wochenschrift*, 1853, 1854.—C. G. Lehmann: *Schmidt's Jahrb.*, 1855, vol. lxxxvii.—Oesterlen: *Arch. f. phys. Heilk.*, 1843.—Duriau: *Arch. Gén.*, 1856.—L. Lehmann: *Arch. f. wissenschaftl. Heilk.*, 1867, i. ii.; *Virch. Arch.*, vols. xxii. and lviii.; *Berl. klin. Wochenschrift*, 1864.—Valentiner: 'Bad Pyrmont,' 1858.—H. Nasse: *Arch. f. gemeins. Arb.*, ii.—Beneke: 'Nauheim's Soolthermen und deren Wirkung.' Marburg, 1859.—E. Schäfer: *Wien. Zeitschr.*, N.F. ii. 1859.—Braune: *Arch. f. pathol. Anat.*, vol. xi.—Rosenthal: *Wien. med. Halle*, iii. 1862.—Clemens: *Arch. d. Ver. f. wissensch. Heilk.*, 1867, iii.—Beneke: 'Ueb. d. Wirk. d. Nordseebades.' Göttingen, 1855.—Parisot: *Gaz. des Hôp.*, 1863, and *Arch. f. wissensch. Heilk.*, 1864.—Delore: *Gaz. Hebdom.*, 1863.—Thomson: *Edinburgh Philosoph. Journ.*, N.S. vol. xvi.; *Schmidt's Jahrb.*, 1864, vol. cxxi.—Villemin: *Arch. Gén.*, 1863 and 1864.—Zülpen: *Centralblatt f. d. med. Wissenschaften*, 1864. — Waller: *Prag. med. Wochenschrift*, 1864, 2. — Zülzer: *Med. chir. Rundschau*, 1864, 4.—Merbach: *Arch. f. Balneologie*, 1863.—Roussin: *Recueil des Mém. de Méd.*, 1867, sér. iii.—Rabuteau: *Gaz. Méd. de Par.* and *Gaz. Hebdom.*, 1869, 14.—Oré: Ibid. 1866.—Demarquay: 'Rech. sur l'Absorption des Agents Médic. par la Peau.' Paris, 1867.—De Laurés: *Compt. Rend. de l'Acad. de Méd.*, 1865.—Reveil: 'Rech. sur l'Osmose et sur l'Absorption.' Paris, 1865.—K. Hoffmann: *Gaz. de Par.*, 1867, 15.—Ritter: *Arch. d. V. f. w. Heilk.*, 1867.—Eulenburg: *Centralblatt f. med. Wissensch.*, 1865, 34.—Scoutetten: *Gaz. des Hôp.*, 1869.—Neumann: *Allg. Wien. med. Zeitung*, 1871, No. 43.—Auspitz: *Jahrb. f. Balneol.*, 1872, i.—Neumann: Ibid. 1872.—Jamin and De Laurés: *Compt. Rend. de l'Acad. des Sciences*, 1872, vol. lxxv.—Röhrig: *Arch. d. Heilk.*, vol. xi. 1872.—Id.: 'Physiolog. d. Haut.,' Berl. 1876, and *Deutsche Klinik*, 1872, Nos. 23–25.—Brémont: *Compt. Rend.*, vol. lxxiv. 1872.—Teissier: *Lyon Méd.*, 1872.—Chrzonsczewsky: *Berl. klinische Wochenschr.*, 1870—Passabosc: *Virch.-Hirsch Jahresb.*, 1873, i. 434.—Fleischer: 'Unters. über die Resorpt. Verh. d. menschl. Haut.' Erlangen, 1877.—O. Lassar: *Virch. Arch.*, vol. lxxvii.

Fuller references will be found in Lersch, 'Fund. d. Balneolog.,' 1868, p. 815, and in Valentiner, 'Handbuch d. Balneotherap.,' 1876, p. 65.

There is no question, in the whole range of balneology, which has raised more, and more unnecessary, clouds of dust (as we can say from the modern standpoint of therapeutics) than the question of the absorption of the constituents of the bath through the skin. Numberless experiments were made on the subject, and gave contradictory results. In no field of experimental observation, as everyone knows, who is at all acquainted with the literature of this subject, do we find more defectively arranged experiments and analyses, more shallow conclusions,

than in this branch. For a long time it seemed as if the ground for the very existence of balneotherapy depended on an affirmative reply to the question of absorption, and many bath practitioners considered the honour and the renown of their baths to be endangered by a negative response. Hence, perhaps, the bitterness of the struggle. In the heat of battle, many did not think at all about the quantity of salts which was to be eventually absorbed in a bath. The qualitative proof, of the presence of one of the constituents of the bath in urine, was sufficient to make them assume, from this, 'a powerful absorption.' As it became more and more evident, that the quantities absorbed in the most favourable cases were only nominal, some, to rescue their favourite idea, were not afraid to associate themselves with homœopathy, and it was contended, that a particle of iron, absorbed from the skin into the lymph vessels, and which thus arrived in the circulation, was widely different, in its physiological and therapeutic effects, from a similar particle absorbed from the stomach or digestive canal.

It would lead us too far, and would be useless, to discuss critically all the *pros* and *cons* of absorption in baths. Anyone, who wishes to study the literature of the subject, I refer to Lersch ('Phys. u. Therap. Fundam.,' Bonn, 1868), and to the chapter on this subject in Röhrig's excellent treatise on the 'Physiology of the Skin.' We shall briefly state the facts which are established.

First as to the power of imbibition of the skin, the so called 'preliminary stage of absorption.' Although a long-continued warm or hot bath may, under the most favourable circumstances, be attended by a slight taking up of water in the hygroscopic most superficial layer of the epidermis, yet, even in the most favourable cases, this absorption is so nominal, that its amount cannot be quantitatively determined. The many attempts which were made to determine the quantity of water taken up, by weighing the body (or, what some, for unintelligible reasons, preferred, the bath water), are in every respect useless, whether they have yielded positive or negative results. The trifling differences, which were detected by some of the most careful of those experiments, cannot afford data for conclusions, in view of the numerous factors which variously influence the weight of the body in a much greater

degree. Factors of this kind are, the transpiration of the lungs, the suppression of the perspiration of the parts immersed, the imbibition of water by the hygroscopic hairs, the exhalation of carbonic acid by the lungs, the formation of sweat in hot baths, the removal of dirt from the epidermis, the adhesion of the particles of water, which remain on the skin in its fine lines, furrows, and folds, after the most careful drying.

While Currie, Séguin, L. Lehmann, Poulet, Kletzinsky found either no difference, or even a slight diminution, of weight after a bath, other experimenters, who were less careful than those just mentioned, found a constant, sometimes a considerable, increase, which they at once attributed to imbibition of water by the skin (Young, Dill, Collard, Madden, Berthold, and others). If Jamin, Durrien, and De Laurés observed a considerable diminution of weight in hot baths, no one can wonder at this, when he remembers the great increase of perspiration and of the formation of sweat in hot baths.

Let us turn to the experiments that have been made on the imbibition of water by the skin.

Krause sought to investigate the permeability of the epidermis by endosmotic experiments, by using isolated pieces of epidermis as walls of partition to different fluids. The results of these experiments turned out very unfavourably, both for epidermis imbibition and for its permeability; and most unfavourably when readily diffusible solutions of salts, and not pure water, were used. It must be added that the experiments were made with dead, not living skin. 'When Krause placed thick pieces of epidermis for days in lukewarm water, its upper and lower layers were penetrated to a certain extent by the water, were softened or loosened, without, however, the water being able to reach the deepest layers. They seemed to be protected by the softened peripheral surface, which retained the water it had absorbed, and they only imbibed water when the outer softened layer was rubbed off. If wide glass tubes, filled with water, were made air and water tight by pieces of epidermis placed across their lower end, the outer layer of epidermis remained, even after the observation of several days and strong pressure, perfectly dry, so that not the smallest drop of moisture could be discovered on the outside, even with the aid of a microscope. When layers of epidermis were used as partition walls between fluids of different density or chemical constitution, there was never any proof of diffusion.' [1]

[1] Quoted from Röhrig, loc. cit. p. 76.

The proof of the power of imbibition residing in the outer layer of the epidermis—a proof which hitherto has only been obtained after immersion of the piece of skin for days in warm water—appeared to remove, from the minds of many, all doubt as to the absorption of water, and of the salts held in solution by it. But this conclusion is unwarranted, for Krause as well as Kletzinsky found that water and salts impregnate only the superficial skin layer, not that they penetrate into its deeper ones. What happens now, with the water imbibed by the upper surface of the epidermis? The supporters of the absorption hypothesis assume, that it gradually penetrates more deeply, and is then absorbed. But the more correct answer is this: the imbibed water evaporates again from the surface after a bath, and the salt molecules which remain, lying in the depressions of the epidermis, are thrown off when it scales away. Possibly these molecules may mechanically assist and accelerate the process of desquamation.

To demonstrate the imbibition of the skin, local baths (of hand, finger, or arm) were taken, with various solutions of salts (iodine, lithium, corrosive sublimate, &c.); after some time the bathed locality was carefully washed, and then immersed in pure distilled water. In it there was usually found the trace of the substance which had been dissolved in the original bath. From this it was concluded, that the skin had imbibed the particular solution of salts.

As a further proof of the power of imbibition of the skin, the altered, and to a certain degree swollen, look of the skin after warm baths is appealed to; but the turgor in these cases is caused by the presence of a larger quantity of blood in the skin. The well-known superficial swelling and maceration of the skin, on the palmar surface of the hands and on the fingers of washerwomen, is also adduced, as well as the similar appearance of the skin on the soles of the feet, of those who suffer from foot perspiration. It is properly assumed, that those parts of the skin which have no sebaceous follicles, as the palm of the hand and the sole of the foot, are particularly adapted for the imbibition of water and for absorption. But we have to deal, in these just named cases, with processes which certainly depend on water imbibition, but which cannot be compared with the conditions of a man who takes a bath, as they differ from them, not only as to the duration of the influence of water, but also in many other particulars (the irritating properties of sweat, of alkaline soaps, &c.)

The skin possesses a powerful safeguard against imbibition in a bath, in the secretion of the sebaceous follicles and the oiliness of the outer layer of the skin. Many people therefore conclude, that at least in baths, which act like soap on the oil of the skin, or which have been preceded by a complete cleansing of the skin, there is no obstacle to the skin's imbibing the bath water. But pieces of skin, even after being treated with ether, and losing their particles of fat, do not loose their glossiness, and the feebleness of their power of adhering to water, and can only be made to imbibe after the operation of water on them for several days.

While we now turn to the proper question of absorption, we may pass by in silence the attempts made to prove absorption through the skin, by the increase of the bodily weight of the bather. The positive results of Willemin, and of others, have an equal number of negative ones opposed to them. Apart from the rough sources of error which belong to this method, apart from the impossibility of the best weighing machine showing accurately the slight differences of weight (when it is loaded with the weight of the body of an adult) which under most favourable circumstances are found, the supposed increase of weight could be explained by the imbibition of the skin, which is not the same thing as absorption.

The solving of the now almost over-ventilated question, of the absorbing power of the skin for water and for salts dissolved in it, has chiefly been attempted by the method of examining the urine. Numberless experiments, with contradictory results, have created a literature on this subject, to wade conscientiously through which would be a sore trial of patience.

The various attempts to get an insight into this question, by determining the specific gravity of the urine, have turned out, as might have been expected, to be insufficient.

A result of more importance, is the proof of an increase of the amount of urine after a bath, which generally keeps pace with the secretion of a specifically lighter urine. This has been shown by many, as L. Lehmann, Merbach, Erlenmeyer, Valentiner, Becker, Röhrig, and others (although even this result is opposed by the negative experiments of others, such as the very important ones of Beneke, who observed a decrease of the amount of urine after

sea baths). Increased diuresis appears to be the rule after warm baths of common water and of various mineral ones. Doubtless this increase of the secretion of urine is only a temporary and passing one, which soon attains a maximum, and then gives place to a compensatory diminution. Although we have not yet before us complete observations, made according to the method of Kaupp, yet it appears probable, from the experiments of Valentiner and others, that the daily amount of urine is not increased even by baths of long duration. Can we conclude that the increased flow of urine after a bath is owing to the absorption of water? Certainly not; neither the increase nor the dilution of urine observed after a bath speak for this. The increased diuresis is sufficiently explained by the suppression of the perspiration in a bath. The possibility too, which has been pointed out by Nasse, and also by Röhrig, that the increased diuresis follows reflexly on the stimulation of the skin nerves, is to be borne in mind. If this be so, then skin-stimulating mineral baths, especially those containing common salt, must be more powerful in their diuretic action than ordinary water baths of the same temperature and duration. As far as I know, there are no complete observations on this subject. Flechsig did not find the excretion of water by way of the urine altered for any length of time, either by common water, or by iron water rich in carbonic acid, inasmuch as the increased secretion of urine, after the bath was over, soon returned to its former standard.

A further proof of the absorption of the salts held in solution in water, was sought for in the quantitative and qualitative examination of the urine. The object was to show, that certain different constituents of the bath appeared after it in the urine, or that substances dissolved in the bath, which, like chloride of sodium, are constituents of healthy urine, were excreted in augmented quantities after the bath.

The most common and obstinate contention was this, that common salt and iron were absorbed by the skin in baths. While the absorption of salt in the bath was almost universally admitted, Beneke showed, in the most striking way, that the amount of chloride of sodium in the urine is never increased by a salt bath. Röhrig regulated the consumption of salt by the body, and its excretion, for five days. Having found that the

excretion of chloride of sodium was pretty constant, he took daily, under the same circumstances, a brine bath of 95° and of an hour's duration. He did not discover, on the days he took the bath, the slightest increase of chloride of sodium. These negative results of Beneke's and Röhrig's agree with those of Valentiner, Homolle, Duriau, Wimmer, Walter, L. Lehmann, Braun, Passabosc, and many others. Opposed to them are the positive results of Alfter, K. Hoffmann, and Neubauer. But the increase of the excretion of salt discovered by them, sometimes lies within the ordinary limits of variation, and sometimes their method of investigation was so imperfect that it could give no accurate results. They have, especially in their conclusions from small differences, often entirely overlooked the daily variations which are normally observed when the diet is not uniform, when the quantity of fluids swallowed varies, or when the amount of exercise taken does so.

What is true of common salt, applies in a still greater degree to the absorption of salts of iron from mineral waters. The examination of the urine is not applicable here, for in the most favourable case the absorbed iron would be excreted only very gradually, and probably not through the urine. The numerous experiments that have been made with the sulphate of iron baths, and the analyses of urine made after them, are, as Röhrig shows, entirely thrown away labour. The experiments made with ferrocyanide of potash, which easily passes into the urine, and is readily diluted, have been without result. L. Lehmann, Alfter, Kletzinsky, Thomson, Grandeau, who dissolved as much as 240 to 300 grammes of ferrocyanide of potass in the water of the bath, could find no trace of iron in the urine.

Similarly, full baths and foot baths with lithion, which can be detected by spectral analysis in such minute quantities, gave negative results, as regards absorption.

Iodide of potass is one of the salts which is distinguished for its great diffusibility, and when absorbed passes quickly into the urine, where it is easily recognised. Numberless experiments have been made with this salt. If positive results have often been obtained from its use, yet this is occasioned by very differing circumstances. The easily decomposable iodide of potass, in contact with the fatty acids of the skin, parts with

its iodine, which is volatile, and, as a volatilised substance, is both absorbed by the skin and is inhaled by the bather. The mucous membranes of the penis and of the anus, and any excoriations of the skin, can, in a short time, absorb recognisable quantities of iodine. (It is well known that a gargle of iodide of potass is sufficient to produce traces of iodine in the urine.) Very great care must therefore be taken in using baths of iodide of potass, for the purpose of proving absorption. All observers, who have guarded against the sources of error already mentioned, have arrived at the conclusion, that iodide of potass is no more absorbed by the skin, than other not volatile substances dissolved in a bath. Kletzinsky, Homolle, Duriau, Merbach, Thomson, Alfter, Heller, Hebert, Valentiner, Roussin, Zützner, Lehmann in Jena, Röhrig, Schroff, Ritter, Rabuteau, Laurés, Braune, Passabosc, Fleischer, and many others arrived at this negative result. Baths with alkalies and acids, with chloride of iron (Krause), with lactate of iron (Quevenne), with tartar emetic and sulphate of copper (C. G. Lehmann), all yielded the same negative results. Only a few positive results, which do not bear a close examination, are opposed to those negative ones.

To decide the question, experiments were further made with certain medicines (opium, morphia, sulphate of copper, tartar emetic, belladonna, digitalis), and their physiological action was watched. But here too, as far as non-volatile substances in aqueous solution are employed, we come almost entirely on negative results, which had indeed long before been the case with the application of watery solutions of opium, morphia, atropin, in the form of fomentations to the skin. Homolle, Parisot, Duriau, who made baths with a quantity of digitalin, corresponding to 2 kilos. of digitalis, with aconitin, chinin, atropin, &c., saw only negative results.

Reference has often been made, in favour of the absorbing power of the skin, to the therapeutic action of baths of sublimate, and to the salivation even induced by them. But, in the sublimate baths given for therapeutic ends, so little attention has been paid to guarding against error, that their results cannot be assigned any real importance, especially when contrasted with the negative results of Séguin, Clemens, and Grandeau.

K. Hoffmann obtained a positive result, not only when he used baths of chloride of sodium or of iodide of potass, but also baths with digitalis (16 baths with about 250 grammes of digitalis). From an iodide of potass bath (50 grammes for a bath) Hoffmann, if the bath was protracted, could always find iodine in the urine. With respect to these positive results we refer to the sources of error in iodide of potass baths, which we have pointed out above. Hoffmann found the pulse go down to 48 beats in the minute after the sixteenth digitalis bath. Along with this there was serious illness. The perusal of Hoffmann's writing does not lead me to consider his results conclusive.

Teissier, who made the person he experimented on use prolonged baths of arsenic and of sublimate (with 2 kilos. of arseniate of soda, or 500 grammes of sublimate), never saw the faintest appearance of absorption.

The enormous preponderance of voices in the negative seemed finally to settle the question of non-absorption, by a healthy skin, of substances dissolved in baths that were not volatile nor corrosive. Even those who had been foremost in lauding absorption as the source of the curative effects of their baths, gradually forsook their advanced posts, and ventured to express their belief in the powerful absorption by the skin, only under the cover of popular treatises on their baths. The experimental work of Chrzonsczewsky, which appeared in 1870, with a sudden blow altered the position of things, and gave a new support to the few remaining advocates of absorption.

It is necessary to recapitulate here, briefly at least, Chrzonsczewsky's chief results, on account of the circumspection and care with which this author arranged his experiments, and of the definiteness of the results which he obtained. Chrzonsczewsky immersed the rumps of living dogs or rabbits which had been shorn, or which had little hair, in 1 to 20 per cent. solutions of morphia, strychnia, atropin, nicotin, digitalin, and other alkaloids, with the anus and the urethra carefully closed, and the surface of the water covered with a layer of oil. In a relatively short time, the symptoms of poisoning of different kinds developed themselves in the animals experimented on, and always led to their death in a longer or shorter period, in proportion to the concentration of the solution. Chrzonsczewsky added various colouring matters to the water (ammoniated carmine, indigo

carmine). After the animals had been immersed for some hours in the colour bath, they passed red or blue urine. If a salt of iron was injected into the *vena cava* of the animal, and the animal then exposed for some hours to a bath of ferro-cyanide of potass, the contents of the cutaneous vessels became of a deep blue colour, while the interspace remained colourless. One can scarcely doubt that Chrzonsczewsky has proved, by these experiments, the permeability of the skin of the animals on which he experimented, for substances neither volatile nor corrosive, dissolved in water; although the question may be asked, as to some of his experiments, *whether some not apparent and not bleeding scratches or cuts, may not have been made in the epidermis, during the not very simple process of shearing or shaving the animals.* At all events, Chrzonsczewsky's experiment on man is open to grave doubts. If the pulse of a boy of 15 sank from 84 to 60 beats, and various gastric and cerebral disturbances occurred, 14 hours after he had been exposed to a sitz bath of 6 hours' duration (!) of the temperature of 95°, with an infusion of digitalis made from 250 grammes of it, the conclusion from this experiment, that there were symptoms of digitalis intoxication, is not to be considered as an impossible one, but certainly as one not capable of positive proof. As compared with the numberless experiments which gave an unfavourable result, Chrzonsczewsky's experiments remain still so isolated, that it cannot be permitted, on their account, to throw over the great majority of observers, who deny that the skin can absorb from solutions of substances that are not volatile.

On the other hand, there is not the slightest doubt, that the skin can absorb substances that are volatile, or of the form of gas or vapour, and also the non-volatile substances, which are rubbed hard into the skin, in the form of salves.

It is absolutely certain, that tincture of iodine, ether of iodine, hydriodic acid, and baths containing free iodine, as baths of iodide of potass, often do cause the absorption by the skin of volatile iodine. On the other hand, Braune could never, with the most delicate tests, detect a trace of iodine in the secretions, whenever he prevented by appropriate measures the volatilisation into the inspired air, of the iodine applied to the skin. If, for instance, a foot was kept immersed

for hours in a concentrated watery solution of iodine or hydriodic acid, and its volatilisation prevented by a layer of oil on the surface of the water, he never found any trace of iodine in the saliva, but he found it readily when the layer of oil was removed. On the other hand, Kletzinsky found iodine in the urine and in the saliva, even when he excluded from the air, with guttapercha, the portion of the skin into which iodine had been rubbed; and Krause and Röhrig perceived the violet smell of the urine, on the application of turpentine to the skin, although they covered the portion of the skin that had been smeared with it, with impermeable tissue. But, even in these ways, it is not so easy to guard entirely against the inhalation of iodine or of turpentine. Demarquay, after pencilling one patient in a ward with iodine, was able to detect that substance in the urine of all the other patients.

There can no longer be any doubt, after the researches of Oesterlen, Voit, Neumann, Roussin, Merbach, and others, that iodine and mercury, when applied in the form of salves (apart from the volatilisation, and from the taking up of both in this aggregate form), when rubbed in hard, penetrate to the sweat and sebaceous follicles, in which the conditions for absorption are distinctly more favourable than on the surface. Here everything seems to depend on the force of the inunction, for Bärensprung and Rindfleisch did not detect mercury in the skin, when the inunction was slight. Röhrig was not able, with the aid of the microscope, to detect any mercury in the tissue of the epidermis in rabbits, on whom mercurial inunction had been practised for some days. On the other hand, Röhrig found mercury in the urine, when he wore a mercurial plaster, of the size of the hand, for two days between his shoulders, and when, by putting on a thick band of collodion outside, he had prevented its volatilisation. Röhrig thought that he might conclude from this, that mercury penetrates into and is absorbed by the skin, only by its volatilisation.

It has further been made probable, by various investigations, that alkaloids and metals dissolved in alcohol, ether, chloroform, and in volatile solvents generally, are absorbed by the skin. While former observers (Parisot) attributed this fact to the power of the solvent to remove oily matter from the skin, Röhrig thinks, that the cutaneous absorption of a medicine depends greatly on its degree of volatility (which is increased by the solution in volatile media). Although, however, Röhrig believes, that non-volatile salts also, when dissolved in very volatile fluids, are, as it were, overpowered by them and made volatile, I cannot say that I agree with him, on the ground of physical laws (compare Nägeli, 'Die niederen Pilze'). When Röhrig

dropped 20 drops of conein on the shorn skin of the belly of a rabbit, and protected the spot from evaporation, the animal died in 28 minutes. But the explanation of this, is the well-known volatility of conein. Röhrig believes, that non-volatile salts, even in alcoholic solutions, evaporate in fine particles along with the alcohol. But such a fact has not been proved, and it is in itself improbable. We cannot well give up Parisot's explanation of the process of absorption, in the application of non-volatile salts dissolved in alcohol, ether, and chloroform, although we must admit that Röhrig's interesting experiments throw some doubts on that explanation.

Further, Röhrig has shown, by a series of important experiments, that non-volatile substances dissolved in water, if they are applied to the skin in a state of very fine reduction, penetrate it and are absorbed. Röhrig, in explaining this phenomenon, properly lays great weight on the force with which the finest particles of water and of salt are propelled against the skin, as well as on their state of extremely fine division. Röhrig's experiments with finely pulverised fluids agree with those of Brémont. It is possible, that the absorption of the salts dissolved in water may sometimes be occasioned by rubbing the skin in a bath or by powerful douches. But, under the most favourable circumstances, the quantities would be minimal, not worthy of notice either physiologically or therapeutically, or so called homœopathic quantities, that is, having no operation.

I have entered more fully, than was perhaps necessary for the scope of this book, on the experiments on cutaneous absorption, which have been last described. I did this, because the experiments of this kind are constantly quoted in balneological writings, as proofs of the absorbing power of the skin; and without any good grounds, as I think I have shown.

It is an established fact, that the skin is able to absorb gas and gaseous substances. The experiments, which have been made by Chaussier, Lebküchner, Nysten, Madden, Gerlach, Röhrig, with poisonous sorts of gases (chloroform, ether, hydrocyanic acid, carbonic acid, carbonic oxide, hydrosulphuric acid), leave no doubt as to the power of the skin to absorb gases.

The expectations, however, which many formed, on the ground of these experiments, as to the physiological and therapeutical action of the gases absorbed in baths of mineral waters, were evidently illusory. As regards the minute quantities of oxygen and nitrogen present in baths, the skin is, in relation

to the at best minimal cutaneous absorption of either of these gases, in a far better position for absorbing them, in the atmospheric air, than in baths poor in oxygen and nitrogen. As to carbonic acid, we do not doubt that a little of it is taken up in the baths that are rich in that gas; but that only occurs, in proportion as the pressure of the carbonic acid of the mineral bath exceeds the tension of that gas in the circulating blood, and in the lymph.

The 'intoxicating' effect attributed to baths rich in carbonic acid, can depend only on the inhalation of the gas developed in the bathing water.

The case is different with other gases, which are not found in the blood, of which we are only concerned, balneologically, with hydrosulphuric acid. We shall have to return to this in treating of sulphur waters.

If we now sum up the most important results of this chapter, they formulate themselves as follows :—

45. *An imbibition of water* (and of the salts dissolved in it) *can take place in a bath, in the most superficial layers of the epidermis. Among the most favourable conditions for imbibition are warmth, long continuance of the bath* (several hours), *removal of oiliness of the skin* (secretion of sebaceous follicles), *whether by previously cleaning the body with soap and water, or by repeated baths, or by the slight soapy action of the constituents of the bath. The palm of the hand and the sole of the foot, having no sebaceous follicles, imbibe water most easily. Imbibition has not absorption as a necessary consequence; indeed, it is probable that the water, which is imbibed by the most superficial layer of the epidermis, evaporates immediately after the bath. The imbibition is, under the most favourable circumstances, of such trifling amount, that its quantity cannot be measured, by weighing the body or in any other way.*

46. *An absorption of the water, and of the non-volatile contents dissolved in it, in ordinary baths, has not yet been proved, in spite of innumerable experiments. The outlets of the sweat and sebaceous follicles are not adapted for the absorption of water. Water can be forced, by strong friction in the bath, into the ducts of the sweat and sebaceous follicles,*

and be there brought to absorption. But, even under the most favourable circumstances, the quantities are so very inconsiderable, that they have no physiological or therapeutical importance.

47. *The skin is pervious to gases and to volatile substances dissolved in the water. In this way hydrosulphuric acid, and free iodine, may be taken up in the bath by the skin, whilst the carbonic acid, which occurs in mineral waters, is capable of being cutaneously absorbed only in baths that are very rich in carbonic acid, and then only in minute quantities, on account of the gas tension of the blood and lymph.*

SECOND PART.

PHYSIOLOGICO-THERAPEUTIC ACTION OF WATER IN ITS INTERNAL APPLICATION.

Thomson: *Froriep's Not.*, 1837.—Schultz: *Hufeland's Journ.*, 1838.—Lehmann: 'Lehrb. d. Phys. Chem.,' Leipzig, 1850, ii. and iii.—Chossat: *Journ. de Physiol.*, v.—Lichtenfels and Fröhlich: *Denkschr. d. math. naturw. Cl. d. k. Acad. d. Wissensch.*, vol. iii. 1852.—Böcker: 'Unters. über d. Wirk. d. Wassers.' Breslau and Bonn, 1854.—Speck: *Arch. f. gemeins. Arb.*, vi.—Böcker: *Nov. Act. Acad. Nat. Cur.*, xxiv.—Liebermeister: *Deutsche Klinik*, 1859, No. 40.—Id.: 'Path. u. Therap. d. Fiebers.' Leipz. 1875.—Mosler: 'Untersuchungen über den Einfluss verschiedener Quant. von Trinkw. auf d. Stoffw.,' *Arch. f. wissensch. Heilk.*, 1857, iii.—Nasse: 'Ueb. d. Einfl. d. Nahr. auf das Blut,' Marburg, 1850, p. 23.—Genth: 'Unters. über d. Einfl. d. Wassertr. auf d. Stoffwechsel.' Wiesbaden, 1856.—Falk: *Arch. f. Phys. Heilk.*, 1852, xi.—Falk and Schäffer: *Arch. f. gemeins. Arb.*, ii.—Bidder and Schmidt: 'Die Verdauungssäfte u. d. Stoffw.' Leipz. 1852.—Bischoff: 'D. Harnstoff als Maass d. Stoffw.,' 1853.—Ferber: *Arch. d. Heilk.*, 1860.—Westphal: *Virch. Arch.*, 1860, xviii.—Winternitz: *Oesterr. Med. Jahrb.*, 1864.—Id.: *Zeitschr. f. prakt. Heilk.*, 1866.—Id.: 'Die Hydrotherapie u.s.w.,' Vienna, 1880, ii. 2, p. 415.—J. Vogel: *Arch. d. Ver. f. wissensch. Heilk.*, 1864.—Smith: *Cannst. Jahresb.*, 1861, i.—Leichtenstern: 'Unters. über d. Hämoglob.-Geh. d. Blut.' Leipz. 1878.—S. Mayer and Pribram: 'Ueb. reflector. Beziehung. d. Magens zu d. Innervat. d. Kreislauforg.,' *Sitz.-Ber. d. Acad. d. Wissensch. Wien*, 1872, iii.—Dreschfeld: 'Unters. aus dem physiol. Laborator. z. Würzburg,' 1867.—Ranke: 'Beob. u. Vers. üb. d. Ausscheid. d. Harnsäure b. Menschen.' Munich, 1858.—C. Voit: 'Physiol. chem. Unters.,' Augsburg, 1857, part i.—Bischoff and Voit: 'Gesetze d. Ernährung d. Fleischfressers.' Leipzig and Heidelberg, 1860.—Beneke: 'Grundl. d. Path. d. Stoffw.,' 1874.—Seegen: *Sitz.-Ber. d. k. Akad. z. Wien*, vol. lxiii.—Eichhorst: *Pflüger's Arch.*, vol. iv.—J. Mayer: 'Ueb. d. Einfl. d. vermehrt. Wasserzuf. auf den Stoffwechsel,' *Zeitschr. f. klin. Med.*, vol. ii. part i., 1880.

FOLLOWING out our plan, we have to consider the action of water, which is common to the most different drinking cures.

We shall return to the pharmaco-dynamic physiological and therapeutical action of the various salts and gases held in solution in mineral waters, when we examine the most important groups of wells.

If we were to commence *ab ovo*, we should have to describe, in the commencement of this chapter, the important share which water takes in the economy of the body, which, indeed, contains 59 per cent. of that element. But this would be an unnecessary undertaking. As life at all is not conceivable without water, so is a certain quantitative balance of the supply of water necessary, if all those numberless functions and cell actions, of which our life is made up, are to proceed within physiological limits. It is obviously not our place to describe this very intricate and many-sided operation of water. We have here, in considering the operation of water in drinking cures, only to do with the physiological and therapeutical effects of increased water drinking. In doing this, we must steer clear of that so common kind of drinking cure, which is confined to the ingestion of one or of a few glasses of a mineral water. In such cases, there can be no possibility of any special action of water, for such patients diminish their usual supply of ordinary water, and thus compensate for any additional quantity they drink of mineral water, so that the sum of all the water they drink is much the same as usual. It cannot, however, be denied, that while the amount of water taken in may be quantitatively the same, it is not a matter of indifference, in what form, or at what hour of the day, it is drunk. When persons who are accustomed to take in their necessary quantum of fluid (apart from the water that is present in their solid food) only in the form of pleasurable drinks, are obliged to satisfy a part of their craving for fluids with plain common or with mineral water, when they thus renounce their usual drinks, the greatest share in the cures of such persons, is rather due to their giving up their ordinary drinks, than to the water which they take. The organism not only finds a certain quantity of water in the twenty-four hours necessary, but it also requires a certain degree of periodicity as to the time when it is swallowed. As the loss and consumption of water in the system are divided through the whole day, so is regularity in hours of drinking necessary to a healthy working

of the system. On this account, drinking cures, in which a large quantity of water is taken in only once a day, and which thus temporarily increase the quickness of the currents of water, and of its loss by the system, may be of use, although there is no change in the total quantity of water taken in within the twenty-four hours. Of course one or two glasses of a mineral water, taken in this way, can be of little moment as regards the mere amount of water.

The water balance of our body may be compared to a reservoir, the height of which must always lie between a fixed maximum and minimum, if the organic functions are to remain normal. Following this comparison, the outflow pipe of the reservoir must open at a certain height above the bottom of the reservoir, and must be able at the same time to alter its cross section in proportion to the pressure of the water. If the quantity of the fluid in the reservoir sinks below the mouth of the outflow pipe, water ceases to flow, and, according to our comparison, life ceases. The quickness of the current, and also our consumption of water, in correspondence with the width of the stream, are increased by a sudden considerable supply of water. The quantity of water that flows away in a given time, can be regulated just as well by a constant small, as by a less frequent large supply. But if the quantity of water necessary for the twenty-four hours were made at once to fill the reservoir, the cross section of the outflow pipe would, on account of the swiftness of the flow, and of our consumption of water, increase to such a degree that, long before twenty-four hours were over, injurious want of water would set in. The necessary sequence of time in taking the water is, excluding our own will, regulated in a certain degree by this, that the organs of absorption do not work in proportion to the quantity of water taken in, but in proportion to the size of the absorbing portion of the digestive canal, which is covered with fluid, and to the varying demands of the organs for water.

The effects of abundant water drinking, are in close connection with the quantity and the temperature of the water taken in.

We consider first the thermal effects. The heating of the water that has been drunk, up to the temperature of the body, is a source of loss of heat to the system. If half a kilo.

of water, of temperature of 46·4°, is to be warmed up to 98·6°, 12·5 calories are required for this purpose.

48. *An effect of cold drink, which has been testified to by many observers, is the lowering of the temperature of the body.*

I shall pass by the older experiments of Lichtenfels and Fröhlich, who determined, in the cavity of the mouth, the temperature after water drinking (!), as well as the experiments of Genth, who measured the temperature between the tips of the fingers (?). I shall turn now to the experiments made by Liebermeister in 1859, which show *that the temperature of the cavity of the axilla is lowered distinctly, by drinking cold water.* Liebermeister's experiment further showed, *that a withdrawal of heat, operating from an interior surface, acts differently from a withdrawal of heat from the skin.* The former makes the temperature of the body sink, and nearly to such an extent as corresponds to the loss of heat, if it be divided equally over the whole body. In Liebermeister's experiments 880 c.cm., of a temperature of 42° (drunk in two portions within half an hour), caused a maximum fall of 0·810° in the temperature of the axilla, from which a small deduction is to be made, for the declining curve of the day.

Winternitz later arrived at the same results as Liebermeister. After the drinking of 500 c.cm., of a temperature of 46·4°, within 25 minutes, the temperature in the rectum sank about 1·85°. The lowering of temperature was slowest in showing itself in the axilla, according to Winternitz, while a gradual sinking of it in this locality could be recognised for 1 hour and 15 minutes. On the other hand, the diminution of temperature was much less in the axilla than in the rectum, reaching a maximum after 74 minutes of only 0·38°.

The experiments of Liebermeister, Winternitz, and others show that the temperature of the body may be lowered also by cold clysters.

The thermal effect of the cold water drunk in a cure is scarcely worth considering.

49. *The pulse frequency is lowered, and the blood pressure increased temporarily, by drinking cold water.*

Lichtenfels and Fröhlich found, as the mean of observations, when 300 c.cm., of 64° temperature, had been drunk quickly,

that the pulse fell in 30 minutes from 96 to 74. This sinking lasts only a short time, so that the pulse is usually in its normal state at the end of 15 minutes. Liebermeister observed, in the above-mentioned experiments, a reduction of 19 beats.

Winternitz observed, after the drinking of 1 litre of water of the temperature of 44°, the pulse frequency fall, in the course of an hour, from 72 to 52. It is probable that the retardation of the pulse, after a copious draught of cold water, is caused by the stimulation of the end twigs of the vagus in the stomach, among other reasons for this, that the retardation of the pulse sets in before the alteration of the bodily temperature commences. Winternitz has also made experiments on alteration of the form of pulse after draughts of cold water. The pulse curve of the radial artery showed, after the drinking of 300 c.cm. of temperature of 90·5°, the usual character of increased tension of the vessels, shorter and less steep systolic rise and disappearance of the secondary wave. Reversely, Winternitz observed, after the swallowing of warm water (300 c.cm., of the temperature of 90·5°), the signs of diminished tension. Winternitz concludes, from his experiments, that the cold water, when arrived in the stomach, reflexly stimulates the vasomotor centre, and in this way occasions protracted contraction of the vessels. The opposite influence of warm water on the pulse curve, Winternitz explains by the feeling of squeamishness which it excites, with which the lowering of the tone of the vasomotor centre is associated. Goltz, Bernstein, Asp, Hermann and Ganz, S. Mayer and Pribram found, in their experiments on dogs and cats, that electric and mechanical, as well as thermal stimulation of the stomach, induced retardation of the pulse frequency, and increase of pressure in the arterial system. We thus have, on one side, a reflex excitement of the obstructing vagus filaments (if these last are cut through, there is no retardation of the pulse); on the other side, a reflex excitement of the vasomotor centre. The action just described, on the pulse frequency and the blood pressure, also occurs, according to Hermann and Ganz, if the mucous membrane of the stomach is stimulated, by the introduction of cold water, or of pieces of ice. Mayer and Pribram challenge this result. Increase of blood pressure and diminution of blood frequency, according to

them, set in only after exciting the muscular coat, as in the case of tearing and stretching the coat of the stomach.

50. *The water brought to the stomach, is, according to the universal belief, absorbed in great part in it.*

This almost universally held physiological dogma has not yet been proved. Pathological experience in cases of *stenosis* of the pylorus, which no doubt, being pathological, are not necessarily always applicable, points against the stomach having a very considerable power of absorbing water. Béclard's experiments make it probable that

51. *Cold water, drunk on an empty stomach, leaves the stomach very quickly.*

Within half a minute after it had been drunk, water appeared in a fistulous opening of the duodenum in a man, and in six minutes in the cæcum of a horse.

The greater portion of the absorbed water probably reaches the veins, which indeed the arrangement of the vessels of the mucous membrane of the stomach and intestines renders probable.

Bouisson considers, that he has found the *vena portæ*, which contained a watery blood, strongly distended in animals, which were killed shortly after they had drunk water.

The results of different investigators are discordant on the question, whether the blood becomes richer in water in any demonstrable way, after free consumption of it. There must be necessarily an increase in the amount of water. Magendie could not, after copious water drinking, detect any diminution of the specific gravity of the blood. Nasse came to the conclusion, that the water amount of the blood is little influenced by the quantity of water drunk. Denis had before that arrived at the same negative result, while Lecanu, and especially Schultz, were able to observe an increase of the amount of water after copious water drinking. In my experiments regarding the quantity of hæmoglobin in the blood, I was not able to detect any increase of water after large draughts of it, in spite of the extreme sensibility of the process of photometry of the absorptive spectra, employed by me. The person, on whom I experimented, drank daily 7 litres of water, and the determination of its amount in the blood took place, at the most different periods,

after it had been imbibed. Böcker's experiments, from which he concluded, that the blood became richer in water in a quarter of an hour after swallowing large quantities of water (several litres), but that within half an hour there was a return to the usual amount, are not satisfactory to me, on account of the way in which they were conducted.

52. *There is no such thing as any considerable increase in the amount of water in the blood, no polyæmia, that can be readily demonstrated, even after copious draughts of water.*

The cause of this is the rapid absorption of water from the digestive canal, and its rapid exit from the body in the urine. In this way, large quantities of water may pass through the body in a relatively short time, without producing any considerable increase in the water amount of the blood, such as can be easily detected. But even in the case of a large quantity of water being absorbed in a short time, and of the intensity of the discharge of water from the body falling far short of the intensity with which it is taken in, the current of the blood, as my experiments have shown, protects itself from being overloaded with water; and in this way, as is readily intelligible, namely, that the increased supply of blood does not distribute itself only to the (say, 10 lbs.) of the blood current, but all over the body, to the fluids of the parenchyma.

53. *We have at hand, in copious water drinking, a means of subjecting the whole system to a powerful washing out. A consequence of this, is the temporary increased excretion of certain products of change of tissue.*

Although, as far as I know, no thorough experiments, not open to exception, have as yet been made on the action of copious water drinking on conversion of tissue, yet experiments up to the present time warrant the following conclusion:

54. *The greater amount of diuresis, after drinking large quantities of water, produces a quantitative increase of the excretion of urea, of chloride of sodium, of phosphoric and of sulphuric acids.*

On the other hand, according to Böcker's and Genth's accounts, the amount of uric acid is diminished by copious draughts of water. Böcker found an increase of 2·8 grammes of urea, as the mean of an experiment conducted for seven days,

when $3\frac{1}{2}$ litres of well water were consumed daily. The increase of salts in the urine, after copious water drinking, has been proved by the experiments of Becquerel, Chossat, Lehmann, Genth, Mosler, and Falk.

Various questions have been asked, such as, Does the increased current, which permeates the tissues, after large amounts of water have been taken, favour the conditions for the decomposition of albumen? does it increase this, and thus augment the excretion of urea? (Bischoff, Mosler, Böcker, Genth, Voit, Herrmann, answer this in the affirmative.) Or does the increase of current merely remove more rapidly the urea already formed (as J. Mayer thinks)? Is the law of compensation good in this case also? All these questions have been answered by many of the above authors, in the sense of increased conversion of the albuminates being the main factor. But, after reading all the experiments made on this subject, I cannot get rid of the impression, that new and thorough experiments on change of tissue, in persons of equal weight in the amount of nitrogenous substances, are desirable, before the question is finally settled.

55. *Unquestionably, numberless drinking cures owe more of their efficacy, in diseases, to the diuretic and washing-out effect of the water drunk in increased quantity, than to the salts and gases dissolved in it.*

We make the most extended use of this washing-out power of water in therapeutics. Copious water drinking may, under proper circumstances, be used efficaciously in many cases: when it is the object to bring exudations to absorption, to wash out accumulated particles of bile from the blood and from the tissues, to increase the secretion of bile and the pressure of the secreted bile, when it is the object to remove certain poisons which have got into the system, or to wash out blocked up urinary tubuli. In all these cases, where large quantities of water are employed, simple water (I include here distilled water, with any addition to make it palatable) is to be preferred to mineral waters or to solutions of salts. And as water, in large quantities, is better borne by the stomach, taken warm, than cold, the use of the former is preferable, and, besides that, it is more rapidly diffused.

It is known that other excretions, besides that of urine, are influenced by copious water drinking. Lehmann observed in the horse an increased secretion of the parotid, the specific gravity of which at the same time became lighter; and Weinmann witnessed a considerable increase in the pancreatic secretion of the animal experimented on, after a large supply of water. Bidder and Schmidt, Nasse, Arnold, found the secretion of bile increased after copious draughts of water, the specific gravity of the bile diminished, and the amount of solid matter excreted through it increased.

56. *Copious water drinking increases the sensible and insensible transpiration of the skin, in health and in many diseases.*

This has been proved by innumerable experiments, which have been made by Ferber, Mosler, Weyrich, and repeatedly in Niemeyer's clinique. J. Mayer has recently advanced, against this, only the fact, that he has not been able to observe a correspondence between the supply of water and the insensible perspiration of a dog (!)

57. *The action of cold water is familiar, as exciting the peristaltic action, and as aperient.*

It is evident that the stimulus of cold here plays the chief part, although the dilution of the contents of the alimentary canal aids their forward movement. Conversely, obstipation sometimes occurs from drinking warm water, frequently even when the warm water contains some slightly aperient salts. This is explained by the action of warm water, which diminishes stimulation, and also dilutes any irritating secretions which may be present in the canal.

As far as I know, experiments have not been made regarding the volume of the respiration or the excretion of carbonic acid, after drinking large amounts of water.

58. *The frequency of the respiration is not observably influenced by drinking cold water.*

In Liebermeister's experiments, there was in one case a slight diminution, in another a slight increase of the frequency of respirations, after drinking a large quantity of water. In Winternitz's experiments, no constant influence on the frequency of respiration could be detected.

THIRD PART.

THE PHARMACO-DYNAMIC AND THERAPEUTIC ACTIONS OF THE MOST IMPORTANT GROUPS OF MINERAL WELLS.

Hitherto we have described those actions of water which, according to its application in the form of drinking or bathing cures, play a very important, if not the most important, part in them. In the sequel, we shall endeavour to appreciate the balneotherapeutic actions of the solid and the gaseous substances, held in solution by the various mineral waters. From the standpoint of general balneology, it will be sufficient to consider the most important constituents of mineral waters, without reference to their occurrence in this or that spring. But it is desirable to lay down some principle for the division of mineral waters into groups, not only from a practical point of view, but with reference to the general plan which we are pursuing. We confine ourselves to an account of the most important groups: for, although the exact quantitative analysis of each particular spring forms one of the foundations of scientific balneology, yet a knowledge of the quantitatively predominating constituents of wells, gives a measure of their action, and is quite sufficient in a therapeutic point of view. The old opinion that prevailed, and even now is held here and there, was that the physiological and therapeutical effects of natural mineral waters were, in a certain measure, the joint result of all the numerous constituents which occurred in them in greater or smaller quantities, or even in traces only. But this opinion has no longer any supporters, among those who judge objectively the operation of drinking or bathing waters. One, or a few, of the constituents determine the character of a spring in its therapeutic application. Complete analyses of springs

belong to special balneology, the business of which is to furnish the most complete possible picture of their composition.

In our classification, we follow the one now almost universally adopted. A rigorous classification is manifestly impossible, whether we attempt to make it on a chemical or on a therapeutic basis. Thus, to give one example to stand for many; various sulphur wells contain a not inconsiderable quantity of soda or of chloride of sodium (Aix-la-Chapelle); again, others contain some sulphate of soda or salts of calcium, so that these sulphur springs might be just as well counted as muriatic, saline, or earthy waters, or might be included in the group of theiopegæ (sulphur wells). Analogous cases might be selected from any other class of waters.

1. THE INDIFFERENT THERMAL WATERS.

WILDBÄDER, AKRATOTHERMÆ (ἄκρατος, unmixed).

Baumann, in Valentiner's 'Handbuch d. Balneotherapie,' 2nd edit. 1876, p. 450.—V. Rentz: 'Die Cur zu Wildbad.' Stuttg. 1869.—Id.: 'Die Heilkräfte der sogenannten indifferenten Thermen,' 2nd edit. Bonn, 1879.

The common character belonging to all the waters of this group consists, (1) in their temperature, which varies between 77° and 152·6°; (2) in the purity of the thermal water and the small amount of its solid or gaseous contents.

There is naturally no law as to the degree of temperature which a thermal source requires to have, but 77° is supposed to be the lowest. Still less is there any general agreement as to the amount of solid or gaseous constituents, that stamps on a spring the title of indifferent. The thermal waters reckoned among Wildbads, have not on an average contained more than 1 solid part to 1,000 fluid parts. Among their salts, the small quantities of carbonate of soda present in them are of most importance. The thermal waters owe to them, and to the absence of lime and magnesia, their much-praised softness in bathing and drinking. Of the gases, oxygen and nitrogen occur most frequently; carbonic acid is present in only very scanty quantities in all of them. Some of them contain traces of hydrosulphuric acid.

Considering their very small amount of salts or gases, thermal waters can only be regarded as springs of warm water.

The physiological and therapeutical operations of warm water are plainly and simply represented in the employment of thermal waters. This circumstance, taken in connection with the recognised therapeutic action of indifferent thermals, is the more important, as it shows us, that even the most variously composed, salts or gas containing baths, owe their wide-spread fame, in many cases, probably solely and alone, to their warm water (along with the other factors of bath life).

The long-known hygienic and therapeutic value of the warm bath, of which the laity as well as the profession has made consistent use from time immemorial, remains the same, whether we employ artificially heated water, or the water of indifferent springs, heated by nature. The only difference between them, is in the mode of heating. The same good effects as are observed at a thermal bath, can also be obtained in private practice and in every balneotherapeutically well-arranged hospital; in short, wherever the methodic use of warm baths is adopted, as one of the remedial agents of medicine. To protect the honour of indifferent baths, and to explain their operation, which no one in these days considers 'wonderful' or unusual, it is not necessary to appeal to the 'amount of nitrogen' or to the 'organic substances' in the waters, 'the barégine, glairine, or theiothermine.' We also judge from the same objective point of view such phrases, as the 'specific, zymotic, or earth heat' coming from the baths, or the hypothesis, that may be applied to any warm bath, of 'colours or tones of heat' or of its 'thermal vibration.' Our purpose is, not to build up theories of 'balneological thermosis' by the help of hypotheses loosely derived from physics; it is rather as follows: (1) To lay the foundation of credible statistics of the good effects of thermal waters in the most different complaints, by making the indications for indifferent thermal waters clearer and better marked, from thorough clinical observation, and by a careful separation of the successful and the unsuccessful cases; (2) with the aid of such methods, as are within our reach, to approach the question, in what way the nervous system, the circulation, the change of tissue, the nutritive, vasomotor, and secreting functions, are influenced by the methodical use of warm baths. In reality a wide field, which has scarcely been entered on, and the cultiva-

tion of which will require much trouble, labour, and earnest patience.

Although successful results are often obtained by the use of a cure of indifferent thermal waters, which could not have been obtained at home, by the use of simple baths of warm water, this has by no means its foundation in any wonderful mystical power of the waters, but rather in the different very important factors, which attend every bath cure. They are such as change of climate, residence in a beautiful wooded country, rest and removal from domestic and professional cares, exercise in the open air, with their frequent consequences, increased appetite, and better nutrition.

It is not necessary to enter on the partially known physiological effects, of the simple bath of indifferent temperature, because the most important part of our information on this subject has been already given above. The degree of action of baths of different kinds, apart from the thermal effects of the cold or hot bath, is chiefly determined by the intensity of nerve stimulation, and the quantity of salts or gas present in the bath stands in direct relation to this. As a consequence, we shall not expect, from thermally and chemically indifferent baths, any considerable influence on the storing of heat, on the change of tissue, on the excretion of carbonic acid or nitrogen, on the circulatory or respiratory functions. But it is different, if, as is the practice in many baths, high temperature and hot baths are used, or, if what is deficient in the stimulating action of the water, is made up for by the active motion of the bath water (rain douches, needle jets, &c.), or by friction, flesh brush, shampooing, &c. Granting all this, there remains an undeniable action, even of indifferent warm water baths, on the skin (cleansing of the skin, production of perspiration after the bath), and also on the nervous system. Many of the experiments detailed above, as well as many therapeutic observations, speak in favour of such influences.

It is a matter, proved by multiplied observation, that the products and the residue of chronic inflammation, and hyperplasia of tissue, can be favourably influenced by the use of warm baths, even of those of indifferent temperature. The old and deserved reputation of thermal springs, in the treatment of chronic rheu-

matism of the joints and muscles, of rheumatic contraction, and false ankylosis, of the effects of past attacks of gout, can hold its own, even against the extreme of scepticism. The methodic use of thermal waters, as of warm baths generally, often improves and cures certain chronic skin affections, ulcerous processes of the skin, badly granulating torpid wounds, fistulas and caries of bone, cicatrices distorting the skin, muscle, sinew, and joint exudations as they remain behind, after luxations, fractures, and gunshot wounds, and often interfere so much with the functions of the parts affected. Chronic exudations also, after pleurisy, pelveo-peritonitis, perityphlitis, peri and para-metritis, may at times be ameliorated by thermal warm baths. Undoubtedly certain affections of the nervous system are suitable for the employment of thermal baths, although there were formerly many overwrought ideas on this subject, when the Wildbads used to be called 'nerve baths.' It is becoming constantly more acknowledged, that comparatively recent cerebral hemiplegias, that tumours of the brain, that tabes, and other forms of progressive spinal paralysis, are not cases suitable for the use of thermal waters, and especially of hot baths. On the other hand, the indifferent thermal waters are often appropriately employed in various forms of old, of stationary cerebral and spinal, and also of peripheral and toxic paralysis (lead paralysis, &c.), further in various neuralgias (sciatica) and hyperæsthesias, in some forms of hysteria, neurasthenia, and hypochondria. The same is true of the drinking and bathing cure, in certain forms and in certain stages of chronic Bright's disease, further in chronic catarrhs of the bladder, of the pelvis of the kidneys, in old cases of syphilis, in recovery after severe mercurial treatment.

This incomplete list of the diseases, which are suited for thermal cures, does not include any single one on which the indifferent waters have a specific action, not one to the cure of which the various warm mineral water baths or the simple warm water bath, might not equally lay claim. This claim at least might be made with as much justice by the salt thermal baths, and the sulphur and earthy ones. Further, the favourite assertion, that the indifferent 'not irritating,' mild thermal waters are peculiarly adapted for 'weak, irritable constitutions,'

and that the irritating salt thermal waters are more suited for stronger constitutions, having more resistance power, is, with our present knowledge, nothing more than a fashion of speech.

The water of indifferent thermal sources, which has, however, been for a long time little used in Wildbads for drinking, is to be preferred to more strongly mineralised waters, when the object is, to introduce into the system large quantities of water, merely for their searching and washing-out effect. Simple warm water is better suited for such monster drinking, than what contains chloride of sodium, or carbonic acid.

I need not here enter on the various aids, which are so often employed at the same time as the waters, at Wildbads. Some of these are, milk, whey, or herb juice cures, the lying in bed after the baths, the fomentations with 'thermal water,' the flesh-brushing, the shampooing, the enveloping in sheets, the sweating cures, the shower baths, the douches, vagina douches, local baths, baths of the organic sediments, thermal vapour and steam baths, inhalation of thermal gases, &c. &c. Many of these processes, though apparently beyond the sphere of balneology proper, certainly play an important part in some cases, while the efficacy of others, such as that of inhaling the thermal gases, rests simply on the imagination.

Most of the places, where indifferent waters rise, may, with reference to the character of their position among woods, and often at a considerable elevation, be regarded as climatic stations.

As regards their therapeutic effects and indications, there is really no difference between the various akratothermal baths. The best proof of this is to be found, by looking at bath writings and at the yearly announcements in the newspapers, and observing the list of the various forms of disease, in which the thermal waters are recommended. The *menu* of disease is not only the same for all thermal baths, but harmonises, in a quite extraordinary way, with the therapeutic pretensions of numberless other waters, which have a different composition.

The table opposite enumerates the most important akratotherms. It includes the temperature of the springs, although that is more interesting pegologically, than therapeutically, for the temperature usually employed is the same everywhere. When the water is too

TABLE I.—THE INDIFFERENT THERMALS.[1]

Name of Spring	Situation	Temperature	Total Solids	Relatively Important Constituents	Height above Sea
Badenweiler	Lörrach, Baden	° 78·8	0·35	—	422
Bath	West of England	107·6–116·6	1·9	Sulph. lime, 1·1; chloride sodium, 0·3	—
Gastein	Salzburg district	95–138·4	0·3	Sulphate sodium, 0·2	1,047
Johannisbad	Bohemia	84·2	0·2	—	597
Landeck	Breslau	89·6	0·2	—	447
Leuk	Canton Wallis	124	1·9	Sulph. lime, 1·5; sulphate magnesia, 0·3	1,300
Liebenzell	Black Forest	73·4–77	1·15	Chloride sodium, 0·7; carbonate sodium, 0·1	284
Neuhaus	S. Styria	95	0·28	—	379
Plombières	Vosges	66–158	0·25	—	425
Pfäffers and Ragatz	Canton St. Gallen	98·6–93·2	0·29	—	633 & 482
Römerbad	S. Styria	96·8	0·2	—	225
Schlangenbad	Nassau	80·6–89·6	0·3	Chloride sodium, 0·2	313
Teplitz	Bohemia	118·4	0·7	Carbonate sodium, 0·4	220
Tüffer	Styria	95–102·2	0·2	—	215
Tobelbad	Styria	82·4	0·49	Carbonate lime, 0·2	330
Warmbrunn	Silesia	96·8–107·6	0·5	Carbonate sodium, 0·1; sulphate sodium, 0·2	338
Wildbad	Black Forest	91·4–98·6	0·56	Chloride sodium, 0·2	400
Bormio	N. Italy	100·4	0·9	Sulph. lime, 0·4; sulph. magnesia, 0·2	1,448
Mont Dore	Auvergne	107·6	1·6	Carbonate sodium, 0·6; chloride sodium, 0·3; carbonic acid (?)[2]	1,036

[1] Degree of temperature according to Fahrenheit; solid parts in the 1,000 by weight; the heights are metres.

[2] In contradiction to other Wildbads, Mont Dore has a large supply of carbonic acid. (It is not usual to class it among indifferent waters.—*Tr.*)

cold, it is heated; when the water is too hot, it is cooled. I also give the totals of solid constituents, although the knowledge of this is really irrelevant for this class of waters. The height above the sea is given in a climatic point of view. I may well pass by the minimal amounts of gas present.

In a therapeutical point of view it would not only be allowable, but it would even be imperative, to include various other baths under the head of indifferent.

To them practically belong, the thermal waters of Baden Baden and of Wiesbaden, remarkable for their small and unimportant amount of common salt; further, all the sulphur baths, so poor in solid constituents, and in which it has long been doubtful, whether their sulphur is of any therapeutic importance. We merely followed the established practice, when we excluded them from this group, and placed them in another one. On the other hand, I could not avoid including at least the lime thermals (Leuk, Bath), although they are distinguished from ordinary indifferent water, by their containing sulphate of lime. I did this, because I really cannot see how the presence of a little gypsum, can be of any importance therapeutically in their outward application. (Compare the account of earthy waters.)

2. SIMPLE ACIDULOUS SPRINGS.

SAUERBRUNNEN, ANTHRAKOKRENEN (Carbon Fountains).

(See Table II.)

Lehmann: 'Lehrb. d. Physiolog. Chem.,' vols. i. and ii. 3rd edit. Leipzig, 1853.—Kerner: *Pflüg. Arch.*, 1870, iii.—Seegen: 'Heilquellenlehre.' Vienna, 1867.—Lersch: 'Fundament. d. prakt. Baln.' Bonn, 1868. —Jakob: 'Grundz. d. allg. Balneol.' Berlin, 1870.—Basch and Dietl: 'Ueb. d. physiol. Wirk. kohlenshalt. Bäder,' *Oesterr. med. Jahrbuch*, vol. xx. 1870.—Buchheim: 'Arzneimittellehre,' 1878, p. 203 et seq.—Nothnagel: 'Arzneimittellehre.' Berlin, 1870.—Quincke: 'Ueb. d. Wirk. CO_2-haltig. Getränke,' *Archiv f. exper. Pathol.*, vol. vii. p. 101. Compare also many of the sources mentioned before and after this.

The simple acidulous springs contain other substances, besides carbonic acid, in such small quantity, that we can scarcely speak of the therapeutic effects of the former. Nevertheless it is the fashion, with the view of raising their reputation, to reckon

springs which contain only a minimal amount of iron, of carbonate or sulphate of soda, of earthy alkalies, as chalybeate, alkaline, muriatic, saline, or earthy.

A thorough and logically carried out classification of such waters cannot be made, and for this reason, that we know nothing of the amount of iron, soda, &c., necessary to make such waters begin to act therapeutically, and further because the rise of scale is very gradual from the most slightly to the most highly mineralised acidulous springs. Every such classification must necessarily have much that is arbitrary in it. I have placed in Table II. only such acidulous springs, as contain very minute quantities of salts or earths.

Acidulous waters rise in innumerable places; there are districts, like the neighbourhood of Eger (the Eifel and Auvergne, Tr.), where almost every village has its spring.

Almost all the springs of this kind are cold, and on this account are used nearly exclusively for drinking. Most of them are exceedingly popular, as pleasantly tasting and refreshing drinks. Hence the enormous manufacture of artificial waters of this kind.

While many common springs, and wells. do not contain more carbonic acid than rain water, and at the highest 50 volumes in 1,000 of water, the quantity of carbonic acid often absorbed by these waters is large, and there are often 1 to $1\frac{1}{2}$ or even 2 volumes of carbonic acid to the volume of water. The quantity of carbonic acid varies periodically in its abundance.

The consideration of this group of waters, gives us an opportunity of examining the physiological and therapeutical effects of carbonic acid. Our actual knowledge on the subject, is in inverse proportion to the immense amount of praise, that is bestowed, in many balneological books, on the carbonic acid of springs.

While distilled water, poor in gas, tastes mawkish, the stimulating influence which the carbonic acid has on the sensory and gustatory nerves of the tongue, produces a pleasant pricking feeling in the mouth. The carbonic acid, when it has reached the stomach, causes a feeling of warmth and tension. The carbonic acid acts here, as a stimulant to the mucous membrane, the nerves, and the muscular fibres of the stomach. It is supposed to increase the secretion of gastric juice, and to excite 'the appetite and the digestion.' While it stimulates the nerves of the stomach, it stretches and gives

more tension to its walls. The movement of the stomach is excited, and it favours the carrying away of the chyme, and eventually of the residual contents of the stomach, into the intestines. The carbonic acid is supposed to continue its peristaltic action in the bowels. In proof of the peristaltic action, we may appeal to the fact, that the swallowing drinks, largely charged with carbonic acid, is followed by eructation of the gas, and that noises are often heard, afterwards, of the gas rolling about in the intestines; and one may appeal to Brown-Séquard's explanation: he attributes the strong movement of the bowels, which occurs in asphyxia, to the accumulation of carbonic acid in the blood, which stimulates the nerves of the intestines. On the other hand, C. Nasse and Schiff deny any influence of carbonic acid on the movements of the intestines. According to other views, the 'paralysing, soothing, anæsthetic properties of carbonic acid,' manifest themselves as soon as the drink containing it has been swallowed. We are therefore at liberty to use this or that hypothetic operation, to explain the therapeutic effect of carbonic acid in 'atonic dyspepsia' or 'cramp of the stomach.' It is equally easy to conjecture, that the most different remote organic functions may be influenced reflexly, by the stimulation of the stomach nerves.

If in the foregoing explanations of the action of carbonic acid, after it has reached the stomach, we have had to avail ourselves very much of conjecture, we shall have to do pretty much the same, when we pursue its further progress in the body. There is no reason to doubt, that a portion of it is discharged by eructation, that it partly remains in the intestines, and temporarily increases their amount of carbonic acid, and that it is partly passed in this way by urine, any more than that a small portion of it is taken up by the blood. Here it is supposed, according to the views of several balneological writers, to occasion remarkable effects, 'to spread itself over the chemistry of the blood,' 'to give greater energy and freshness to the organic functions, to influence the nervous system in the way of 'well intoxication,' and further, like the first stage of the operation of alcohol, 'to make the head freer and the thoughts clearer.' It cannot be denied absolutely, that in the intoxication caused by alcoholic drinks, containing carbonic acid, that gas may have a subordinate

action. Therefore an influence of the carbonic acid, swallowed in large draughts of a mineral water well charged with it, on the nervous system, and on the sensorium, is not to be entirely overlooked. But can this still questionable influence, be of any balneotherapeutic value for extended neurophysiological and pathological conclusions?

Very erroneous opinions seem to prevail frequently, about the quantity of carbonic acid, which can reach the blood under the most favourable circumstances, after drinking carbonated waters. On this subject it may be sufficient to give a calculation of Quincke's. Let us take one of the wells that is richest in carbonic acid, the Schwalbach Weinbrunnen. We have in 500 c.cm. of it 2·7 grammes of carbonic acid, of which a large portion is certainly lost in procuring and in drinking it, and by eructation; but let us assume 2·5 grammes as the amount of gas absorbed. We know from Vierordt's experiments, that at the temperature of 67° about 0·5 of a gramme of carbonic acid is excreted every minute from the lungs. The 2·5 grammes just mentioned, are therefore equal to the amount of it excreted by the lungs in five minutes. The facility, with which the quantity of carbonic acid may be excreted almost to double its usual amount, by an increased number or depth of the respirations, or by increased pressure of carbonic acid in the blood, makes it possible, that the supposed 2·5 grammes of carbonic acid, taken up at once by the whole mass of the blood, may be again excreted within a few minutes. But the gaseous carbonic acid of the digestive canal is, owing to its slight diffusibility, taken up but slowly, and in small quantity, by the blood. In addition to this, the carbonic acid absorbed in the water, which has arrived in the stomach and digestive canal, only gradually becomes free there, and the carbonic acid, that has joined the number of gases in the digestive canal, is absorbed, only in proportion as the pressure of the carbonic acid in the stomach and digestive canal, exceeds the carbonic acid tension of the blood. Owing to the width and yielding nature of the way, which stands open for the escape of carbonic acid, the quantities of carbonic acid, which gradually pass over from the stomach and digestive canal to the blood, can be eliminated without any difficulty. We can, therefore, only agree with Buchheim when

he says, 'It is impossible, with unimpeded respiration, to produce any considerable increase of the quantity of carbonic acid in the blood, by the introduction of carbonic acid into the stomach, for instance, by copious draughts of carbonated waters.'

If the quantity of carbonic acid in the blood were increased in any marked degree, there must also be an increase of carbonates in the urine, for, according to the experiments of Planer, Pflüger, Ewald, the carbonic acid tension of the urine is dependent on that of the blood. The assumption formerly entertained, that the amount of carbonic acid in the urine was considerably increased by the use of carbonated drinks, is contradicted on the ground of experiments by Marcet, Wöhler, Buchheim; and Lehmann and Kernig could only detect a very small increase of carbonic acid in the urine.

The assumption, that the copious use of carbonated drinks occasions an increased excretion of oxalic acid in the urine (oxaluria) (Donné, Lehmann), is not yet proved, and the explanation of this occurrence is entirely hypothetical. It was this: that, in consequence of the supply of carbonic acid, the uric acid, as well as the derivatives from the sugar-containing substances, underwent imperfect combustion—that is, not to the last stage, carbonic acid, but only to oxalic acid, i.e. to $H_2C_2O_4$ instead of to CO_2. Cantani could not detect any increase of oxalic acid in the urine, after administering large quantities of carbonated waters.

Opinions, about the diuretic action of carbonic acid, used to be tolerably agreed. Therapeutics has long made use of this practical experience, and reckons, no doubt rightly, carbonated drinks as among the best diuretics. But we know more accurately about this, only since Quincke's experiments. *Drinking water rich in carbonic acid acts as a diuretic, inasmuch as the secretion of urine becomes more abundant, in the hours after it has been drunk, than after drinking the same amount of common water.* This increase of diuresis cannot be caused by the blood, become richer in carbonic acid, increasing the secreting activity of the kidneys, or by its stimulating some of the nervous centres, which preside over secretion, for the blood is not made richer in carbonic acid by drinking carbonated waters. There also can be no reflex transference of the stimulus

of carbonic acid, from the mucous membrane of the stomach to the nerves of the kidneys, or to their centre; for there is no increase of diuresis, after taking an effervescing powder with little water. The increased excretion of water through the urine, after taking carbonated drinks, can only be caused, according to Quincke, in this way, that the carbonic acid (in consequence of the hyperæmia of the mucous membrane, which it excites) materially accelerates the absorption of the water that has been drunk. This, perhaps, will explain the known fact, that alcoholic carbonated drinks produce intoxication more quickly than those which are not carbonated.

The swallowing of strongly carbonated drinks, has no influence, worth mentioning, on respiration, pulse, or blood pressure. In Quincke's experiments on a dog, after giving him carbonated water, the respiration was sometimes unaffected, sometimes less frequent and less forcible. The retardation of the respiration, Quincke thinks, is to be considered, as a reflex action of the coats of the stomach. Lichtenfels and Fröhlich also observed retardation of the respiration; others, again, found acceleration of it. No less different opinions are entertained respecting the influence of carbonated drinks on the pulse. Braun, Seegen, Diruf, found it accelerated; Lichtenfels, Fröhlich, and Kerner found it retarded. Quincke observed both. (Compare what was said above, pp. 329, 330.) The blood pressure, according to Quincke, is not altered.

After what has been said, the therapeutic value of the internal use of carbonated waters, as far as it is yet ascertained, can be expressed in a few words. They are pleasant, refreshing drinks, and therefore liked as articles of enjoyment. They are suitable for dyspeptic conditions, especially in acute indigestion, in nausea, and inclination to vomit. They probably further the secretion of the gastric juice, the absorption of the ingesta, and thus relieve indigestion. They also get the credit of being useful, in sluggishness of the peristaltic action of stomach and intestines, which action is stimulated by carbonated drinks.

Some, like Diruf, attribute to carbonated waters, an action on the secretion of other mucous membranes, and especially of the respiratory tract, in which they are said to produce 'an increase of the secretions, a fluidifying and easier removal of mucus.' If carbonated warm water

has this power, then it owes it solely to the warm water, not to the carbonic acid.

The carbonated drinks act as diuretics, because their carbonic acid quickens the absorption of water in the stomach and digestive canal, and thus temporarily augments the stream of water that passes through the kidneys.

Various other actions, especially on neuroses, are ascribed to acidulous water, and explained in the favourite way, by reflex action. Such action may take place, in the dyspeptic form of headache, in vertigo from the stomach, and in gastric headache. I may mention, as a curiosity, that a power of retarding change of tissue was ascribed to the acidulous waters, on the idea, that the carbonic acid, which reached the blood, acted as a depressor of the combustion processes, which go on in the system.

Carbonated waters, used as clysters, are more aperient, than ordinary water.

The local application of these waters to the os uteri and vagina has got the credit of being emmenagogue, bringing on menstruation, and exciting contractions of the uterus.

Carbonic acid plays a part in a great many variously mineralised baths. We have the action of the mineralised and gaseous bath, deduced from a stimulation of the cutaneous nerves, alike, whether this is evoked by carbonic acid, by iron, by chloride of sodium, or by other salts. Whether or not the carbonic acid, the salt, and the iron, set a-going qualitatively different forms of movement of the nerves, it comes in reality to this, that, so far as concerns the possible operation of the skin stimulation on change of tissue, the respiration, the circulation, on vasomotor, nutritive, and secreting functions, the only one thing of importance, is the quantity of the stimulants, the strength of the stimulation. We must stand by this simple point of view, until the opposite is proved. *We cannot, therefore, speak of a specific action of the carbonic acid of a bath, any more than of that of its iron or chloride of sodium.* It would be desirable to know, what quantities of carbonic acid, of iron, and of chloride of sodium, are equivalent to each other in a bath, with reference to their power of skin stimulation.

It follows, from what has been said, that, *for the present, we cannot speak of any specific indications for the use of the car-*

bonic acid in baths, in different complaints. Therapeutic experience and practice teach this, because very different salt and gaseous baths are successfully prescribed for one and the same disease. Carbonated baths are therefore adapted for all diseases, in which iron and chloride of sodium baths are employed; and, although the therapeutic use of some of these baths—for instance, strong salt ones—has some special indications, yet no one can seriously deny, that the same effects may be produced in some cases by carbonated baths, possessing the same strength of skin stimulation.

It may be advanced against this view, and in favour of a much more powerful operation of carbonated, than of mineralised baths, that gaseous carbonic acid penetrates the skin, as the older experiments of Autenrieth, Legallois, and Abernethy, and the newer ones of Gerlach, and especially of Röhrig, show. Although this, strictly speaking, applies only to the gas, yet it may be inferred of gaseous water baths also.

We know, that in a strongly carbonated bath, the body is soon covered with a number of gas bubbles. These adhering bubbles, which are subject to the pressure of the water, may be partially taken up by the skin. But the whole process is to be regarded, not as a filtration of carbonic acid through the skin into the blood, but as a very gradual and protracted process of diffusion through the epidermis, in which the degree of carbonic acid tension of the blood is an important element. The quantities taken up in the bath are, under the most favourable circumstances, so small (in proportion to the quantity of carbonic acid made and excreted by the body during the same time), and altogether so minimal, that no considerable increase of the number or depth of the respirations is required, to remove at once any excess of carbonic acid, that has been taken in by the skin. People do indeed appeal to the disturbance of the head, and to the giddiness (the bath 'intoxication'), which are observed in some bathers from carbonated baths, and consider this a result of cutaneous absorption. But, granted that the head disturbance is caused by the carbonic acid, it is a much simpler explanation to suppose that it has been caused by the gas inspired in the bath.

Although such actions are proclaimed in all seriousness,

it is difficult to understand, what therapeutic action, in disease, these minimal amounts of carbonic acid, taken in by the skin, can have.

The carbonated baths are said to stimulate the skin more powerfully than the salt ones, and for the reason that, in the former, the carbonic acid, which penetrates the skin, directly stimulates the terminations of the nerves. A consequence of this over-stimulation is said to be, weariness, and a secondary calming of the whole nervous system. But, according to the experiments of Basch and Dietl, as also of Jakob, carbonated baths leave behind them increased sensibility of the skin. Santlus observed the same after strong salt baths.

In laying down the indications for carbonated baths, practitioners referred, according as might be wanted, to their stimulating or to their calming effect, on the cutaneous nerves. They were supposed to influence, by their stimulation, the change of tissue, the circulation, the movement of the lymph, the nutritive, vasomotor, and secreting functions, and thus to be curative in the most different forms of disease. To their anæsthetic operation was ascribed the lowering of the cutaneous sensibility (which still has to be proved), the 'calming of the nervous system;' and in this point of view carbonated baths were recommended for hyperæsthesias, neuralgias, *pruritus cutaneus*, further also in hyperkineses (contractions, cramps, &c.)

Passing by the application of acidulous waters in the form of douches, injections, &c., we turn briefly to carbonic acid gas baths. The generation of carbonic acid in them, is either spontaneous, or is favoured by various processes of generating it —either by agitating the water, or by heating it. The gas baths are always moist, sometimes almost saturated with aqueous vapour, their amount of carbonic acid reaching at most to 30 volumes per cent. The body is either enclosed in a wooden box (with the exception of the head), into which the gas of the spring is conducted, or it is completely exposed to the gas bath. In the larger gas basins, as in many grottoes and caverns, the carbonic acid rises little more than to 3 feet from the floor, so that a person standing in them has respirable enough air to breathe. If the well gas, collected in a pipe, is made to stream out directly against the affected part, this is

called a gas douche. In the inhalation of such well gases, of which carbonic acid is by far the most prominent, that gas can only operate in a way opposed to the object of ordinary respiration. One cannot see what is to be gained, in the way of therapeutic effects, by the inhalation of well gases, and the theory of the operation of gas baths has equally weak foundations. If I am not mistaken, this employment of gas has originated with mere bath speculators. It is not to be doubted, that the inhalation of aqueous vapour, and of air saturated with moisture, which takes place in baths of carbonic acid, may be useful in some affections of the organs of respiration.

TABLE II.—PURE ACIDULOUS SPRINGS AND SUCH AS CONTAIN LITTLE SALTS.[1]

(The carbonated salts as bicarbonates free of water; contents in one litre of water; reduction of the gases to 0 and 760 mm. barom.; carbonic acid in cubic centimetres.)

Name of Well	Situation	Sum of Solids	Free Carbonic Acid in C.ctm.	Relatively most Important Constituents
Apollinaris Brunnen	Ahr Valley, Rhine	2·2	1,521	Bicarb. sodium, 0·9; chloride sodium, 0·3; sulphate sodium, 0·2
Brückenau, W. Well	Bavaria . .	0·1	1,165	—
Charlottenbrunn .	Silesia . . .	0·4	372	Bicarb. calcium (magn.), 0·3
Cudowa, O. Brunnen	Silesia . . .	0·4	1,198	Ferrobicarbon., 0·02
Carlsbad, Dor. Well	Bohemia . .	0·1	555	—
Fideris, Prätigau .	Switzerland; 1,056 metres high	1·5	686	Bicarb. sodium, 0·7; bicarbon. iron, 0·01
Flinsberg, Queis Well	Silesia; 502 metres high	0·7	927	—
Gleichenberg . .	Styria . . .	0·1	932	Bicarbon. iron, 0·01
Heppinger Well .	Ahr Valley, Rhine	2·3	726	Bicarb. sodium, 0·9; chloride sodium, 0·5; sulphate sodium, 0·3
Imnau, F. Well .	Würtemberg .	2·2	1,160	Bicarb. calcium, 1·4

[1] Compare what was said above (p. 343) about the principle on which different wells were selected for this group. We have given only such as contain less in the 1,000 parts than 0·03 of bicarbonate of iron, 1·0 of chloride of sodium, 1·0 of bicarbonate of sodium, 1·0 of sulphate of sodium, 2·0 bicarbonate of calcium and magnesium.

Name of Well	Situation	Sum of Solids	Free Carbonic Acid in C.ctm.	Relatively most Important Constituents
Landskron Well .	Ahr Valley, Rhine	2·0	672	Bicarb. sodium, 0·8 ; chloride sodium, 0·4 ; sulphate sodium, 0·2
Liebwerda, Trinkbrunnen	Bohemia . .	0·1	510	—
Marienbad,	Bohemia			
Ambros. W. .	. . . . .	0·8	1,173	—
Carolin. W. .	. . . . .	1·7	1,514	Bicarb. iron, 0·02; bicarb. calc. (magn.), 0·8 ; sulphate sodium, 0·3
Nauheim, Säuerling	Hesse Darmstadt	0·9	509	Bicarb. sodium, 0·2 ; chloride sodium, 0·2 ; bicarbon. calcium, 0·3
Neuenahr,	Ahr Valley, Rhine			
Augusta W. .	. . . . .	1·4	593	Bicarb. sodium, 0·8 ; temperature, 89·6°
Mariensprudel .	. . . . .	1·4	310	Bicarb. sodium, 0·7 ; temperature, 102·2°
Niedernau, Olga W. .	Würtemberg .	1·4	584	Bicarb. calcium, 0·9
Passug, Belvedere W.	Switzerland . .	2·7	1,041	Bicarb. sodium. 0·3 ; bicarbon. calcium, 2·0; bicarb. iron, 0·03
Reinerz, Cold W. .	Silesia . . .	1·4	1,465	Bicarbon. iron, 0·01 ; bicarb. sodium, 0·3 ; bicarbon. calcium, 0·6
Rippoldsau, Prosperschacht W.	Black Forest .	1·4	712	Bicarbon. iron, 0·01 ; bicarb. calcium, 0·7
Schwalbach, Linden W.	Hesse Nassau .	0·9	1,000	Bicarb. calcium (magn.), 0·7
Sinzig	Rhine Valley .	0·8	530	—
Tarasp, Karola W. .	Engadine . .	1·2	892	Bicarbon. iron, 0·02 ; bicarb. calc. (magn.), 0·9
Teinach, Bach W. .	Würtemberg .	2·6	1,235	Bicarb. calcium, 1·2 ; bicarb. sodium, 0·8
Wildungen, G. V. W.	Waldeck . .	1·4	1,322	Bicarb. calcium (magn.), 1·2 ; bicarbon. iron, 0·02

3. THE ALKALINE SPRINGS.

(See Table III.)

Aubert: 'Ueb. d. Frage, ob. d. Mittelsalze auf endosmot. Wege abführen,' *Zeitschr. f. rat. Medic.*, 1852, p. 225.—Buchheim: 'Ueb. d. Wirk. d. Glaubersalzes,' *Arch. f. physiol. Heilk.*, 1854, p. 93.—Id.: 'Ueb. d. Bildung kohlens. Salze im Darmkanal,' *Arch. f. physiol. Heilk.*, 1857, p. 234.—Id.: 'Arzneimittellehre,' 3rd edit. 1878.—Nasse: *Arch. d. Ver. f. wissensch. Heilk.*, 1863, vol. vi.—Münch: *Arch. d. Heilk.*, 1863, vol. vi.—Seegen: 'Ueb. d. Einfl. d. Glaubers. auf d. Stoffwechsel,' *Virch. Arch.*, 29, 1864, p. 558.—Voit: 'Ueb. d. Einfl. d. Glaubers. auf d. Eiweissumsatz,' *Zeitschr. f. Biologie*, 1865, p. 195.—Seegen: 'Unters. üb. d. Einfl. des Carlsbader Mineralw. auf den Stoffwechsel,' *Wien. med. Wochenschr.*, 1860.—Scheremetjewski: 'Ueb. d. Aender. d. respirat. Gasaustausches durch Hinzufügung verbrennlicher Molecüle zum kreisenden Blute,' *Ber. d. Ges. d. Wissensch. z. Leipzig. Math. naturw. physik. Cl.*, vol. xx. 1868, p. 114.—Lehmann: 'Lehrb. d. phys. Chemie,' 3rd edit., Leipz. 1853, vol. i.—Gallois: 'Mémoire sur l'Oxalate de Chaux dans les Sédimens de l'Urine . . . .' *Gaz. Méd. de Paris*, 1859.—Radziejewski: *Berl. klin. Wochenschr.*, 1876, Nos. 25, 26.—Röhrig: *Oesterr. med. Jahrb.*, 1873, p. 240.—Külz: 'Beitr. z. Path. u. Therap. des Diabetes,' Marburg, 1873, and *Deutsch. Arch. f. klin. Med.*, 1873, vol. xii.—Kratschmer: 'Ueber Zuckerausscheid. beim Gebr. von Na_2CO_3 und Na_2SO_4, *Sitz.-Ber. d. Wien. Acad. d. Wissensch.*, part iii. vol. lxvi.—Grossmann: 'D. alk. Quellen, in Valentiner's Handb. d. Balneotherap.,' 1876.—Riess: 'Ueb. d. Einfl. d. Carlsbader Wassers auf d. Zuckerausscheid.,' *Berl. klin. Wochenschr.*, 1877, No. 39.—Rutherford: *Transact. of the Royal Society of Edinburgh*, 1879, p. 133.—Zülzer: 'Ueb. d. Einfl. d. salin. Laxant. auf d. Stoffwechs.,' *Verhandl. d. balneolog. Sect. a.* 25. *Jan.* 1879. Immermann, in 'Ziemssen's Handb. d. spec. Path. u. Therap.,' vol. xiii. 2, p. 499.—Cantani: 'Spec. Path. u. Therap. d. Stoffwechselkrankh.,' i. and ii. Berl. 1880.—Fürbringer: 'Z. Oxalsäureausscheid. durch d. Harn,' *Deutsch. Arch. f. klin. Med.*, xviii. 1876.—P. Guttmann: 'Ueb. d. therap. Werth d. Carlsbader Mühlbrunnen b. Diabetes mell.,' *Berl. klin. Wochenschr.*, 1880, No. 32. Compare also the preceding literature notices.

The sources belonging to this group, are distinguished by containing a greater or less amount of carbonate of soda, and of free carbonic acid. They are divided into three classes, according to the absence or presence in them of chloride of sodium, and sulphate of sodium—

1. The alkaline wells or acidulous alkaline waters (their amount of bicarbonate of sodium reaching 1 per 1,000 parts or more).

2. The alkaline muriatic wells (amount of chloride of sodium 1 per 1,000 parts or more).

3. The alkaline saline wells (amount of sulphate of sodium 1 per 1,000 parts or more).

These groups of wells give us an opportunity of discussing the therapeutic properties of carbonate of sodium, and of sulphate of sodium. The action of the chloride of sodium contained in the alkaline muriatic waters will be handled, under the head of the salt waters.

The carbonate of soda, which reaches the stomach, is decomposed there, by its acids. Chloride of sodium is formed, and under some circumstances also lactate, butyrate, and acetate of sodium, while the carbonic acid is set free. The neutralisation indeed is only seldom a complete and mutual one, when equivalent quantities of soda and of gastric acid happen to meet. In most cases there remains a surplus of acid, or a surplus of alkali.

Even when the contents of the stomach have at first a neutral or a weak alkaline reaction, as when no food has been taken for several hours, neutralisation of the bicarbonate of sodium is effected, because the secretion of gastric juice is excited, whenever the carbonated water is swallowed. It is well known, that the alkalies, even in weak solutions, are among the articles which increase the secretion of gastric juice, as the experiments made with fistulas of the stomach prove. The carbonic acid, disengaged from the bicarbonate of sodium in the stomach, and the chloride of sodium work also in the same direction.

As digestion does not take place in neutralised or alkaline gastric juice, it is evident, that the swallowing of large quantities of soda waters, during or immediately after a meal, may act injuriously; this especially in atonic dilated stomachs. That may happen here, owing to the neutralisation of the contents of the stomach, which we see in hatching ovens, when we digest portions of albumen with neutralised gastric juice. Putrefaction at once sets in. Yet there may be cases, when the supply of small quantities of soda water may be of advantage during and after a meal. This is when there is an excess of acid in the stomach. There is a definite percentage amount

for each acid, with which decomposition takes place most easily. When there is too much acid, the digestion is retarded, and may in the end be stopped. It has been said, in praise of neutralisation of the contents of the stomach by soda water, that the conversion of amylaceous substances into dextrin and sugar, which has commenced in the mouth, is in that case made possible in the stomach also. It is obvious, that this can be of advantage only when the food consists solely of amylaceous bodies, and not when it contains albuminates. We also know, from the experiments of Frerichs, Lehmann, Schiff, Ebstein, Jakubowitsch, and others, that moderate quantities of acids in the stomach, do not interfere with the conversion of the starch into sugar, that they do not destroy the activity of the saliva ferment. The soda waters, when they have reached the stomach, excite its peristaltic action, especially if they have been drunk cold. We do not know, whether this is the effect directly of the carbonate of soda, or of the carbonic acid and chloride of sodium, into which it is decomposed. In any case, if we wish to assist the expulsion of the contents of the stomach, we should give the muriatic, and still more the saline, soda waters the preference over the simple acidulous ones, and among the latter we should prefer, for this object, those that are richest in carbonic acid.

Let us now look at the therapeutic indications, which are to be derived from what we have said. The carbonated soda waters have long been much used in medicine, in chronic catarrh of the stomach, and are a favourite prescription in certain dyspeptic conditions. In those cases of catarrhs, in which large quantities of mucus are secreted, which collect especially in the empty stomach, and, along with a similar collection in the throat, cause morning sickness, soda waters, drunk on an empty stomach, loosen its mucus, assist its removal, cleanse the mucous membrane, and prepare the way for digestion. In cases of catarrhs with great formation of acid, the alkalies serve to neutralise a part of the free acid, and can thus, by establishing a proper amount of acidity, favour digestion. Abnormal quantities of acid almost always arise from abnormal states of fermentation.

It is a mistaken idea, to attribute to the soda water a

favourable influence also over the cause of the abnormal fermentation in the stomach. On the contrary, alkaline fluids form an excellent foundation for the elements of fermentation. On this account, the soda waters are to be condemned, in many cases of dilated stomach, where, by alkalising the contents of the stomach, they favour the generation of fermentative elements, and only still further distend the flabby walls of the stomach, by the development of carbonic acid: they are particularly to be rejected, when the muscular power of the stomach, or its reflex excitability, is depressed, or when a mechanical obstruction of the pylorus stands in the way of the contents of the stomach being emptied. Soda waters are suitable only when there either is simply abnormal generation of mucus, or abnormal formation of acid, along with a peristaltic action in working order, and with a free road for the expulsion of the contents of the digestive canal, and, in these cases even when abnormal excitants of fermentation seem to be present in the stomach.

It may be said to be universally recognised, that alkaline waters are contraindicated in a great number of stomach catarrhs, and dyspepsias, which, like the catarrhs of the anæmic, of fever patients, of convalescents, are attended by a deficiency of acid.

If the chief object is to neutralise large quantities of acid, or to loosen mucus, then the stronger alkaline waters are to be chosen (Vichy, Bilin, Fachingen, &c.), while the salines (Carlsbad, Marienbad, Tarasp, &c.) or the muriated ones (Ems, Luhatschowitz, Selters, Roisdorf, &c.) deserve preference, whenever the object is to promote, by stimulation of the peristaltic action, the removal of stagnating remains of food, large accumulations of mucus, &c.

Have the alkaline waters, beyond this, any direct salutary influence on the disordered mucous membrane of the stomach? People speak of an 'anti-catarrhal alterative,' of a 'tone-restoring' and 'calming' effect of soda waters in catarrhs, dyspepsias, atonies, gastralgias. These are merely roundabout expressions for the undoubted good effects of soda waters in many of those cases, as proved by experience. One would perhaps be most inclined to answer the above question affirma-

tively, on recollecting the admirable results produced by ordering Carlsbad water in *ulcus ventriculi*, when at the same time the general regimen and diet of the patient were properly regulated. But in this as well as in that case, the good effects are indirect, inasmuch as the neutralisation of the contents of the stomach stays the progress of the peptic ulcers, the chloride of sodium and the sulphate of sodium prevent the stagnation of the contents of the stomach, and in this way render the conditions of cure more favourable.

In the case of treating certain chronic stomach catarrhs, with the muriated alkaline waters, perhaps something should be attributed to the influence of their chloride of sodium in separating pepsin from the cells of the glands of the stomach, which contain albuminates. Much is not to be expected of any antifermentative, antizymotic power of the chloride of sodium present in this class of waters.

On the other hand, I must shortly allude to the appetite-exciting action of soda waters, in certain cases of nervous anorexia (dyspepsia). Here, as everywhere, the accompanying favourable factors of a bath cure must not be overlooked.

Owing to the relatively small amount of carbonate of soda in alkaline waters, and owing to the slow diffusibility of the salt, it generally becomes fully neutralised, after remaining some time in the stomach. In even the most favourable cases, but small quantities of carbonate of soda reach the intestine. They may come to be absorbed there, when the reaction, from the mixture of the pancreatic juice and the bile, is a weak neutral one. It is possible, that the carbonate of soda, acting along with the neutral bile and the alkaline secretion of the pancreas, may have a modifying influence on the process of digestion, excited by these secretions. As the acid of the stomach chyme, which has arrived in the duodenum, reflexly excites the secretion of bile and of the pancreatic juice, perhaps diminished secretion of those fluids may result from the chyme, which has been made neutral or alkaline by the carbonate of soda.

The carbonate of soda, chloride of sodium, sulphate of soda, and carbonic acid in the waters, when they reach the digestive canal, excite peristaltic action. It is well known, that Liebig

attempted to explain the action of salines as a physical act, depending on the law of endosmosis. In these days the question, how purging follows the introduction of salines, is always answered in the sense, that they, by stimulating the nerves of the stomach and intestines, excite reflexly the peristaltic movements, and thus accelerate the removal of the fluid contents of the digestive canal. We need not examine, in detail, the decisive experiments on this subject of Aubert, Thiry, Schiff, Moreau, Radziejewsky, Buchheim, and others.

Many soda waters, especially the saline ones, owe a great portion of their curative effects to their purgative action. In connection with this, we refer to various chronic catarrhs of the intestinal canal, in which they, especially the muriatic and saline ones, often do excellent service. If the catarrh is dependent on the presence of too much acidity in the chyme passed into the intestine, then the neutralising effect of the carbonate of soda is useful. If atony of the muscular coats, or diminished reflex excitability of them, is the cause of the stoppage of the contents, with its daily injurious influence on the mucous membranes, then the peristaltic action of the saline laxatives occasions a quicker passage of the injurious contents, favours the conditions of normal digestion, removes the source of the chronic irritation of the mucous membrane, and quiets the abnormal fermentation of the contents of the duodenum.

Various liver affections (cirrhosis, jaundice from obstructed bile ducts, venous hyperæmia, attending heart and lung diseases, fatty liver, &c.) have chronic catarrh of the bowels as a secondary consequence, owing to obstruction of the *vena portæ*. Idiopathic chronic catarrh of the bowels, on the other hand, as is often found in great eaters, in hypochondriacs, in people of sedentary habits, and those who suffer from hæmorrhoids, occasions venous hyperæmia of the canal, and defective movement of the blood from the distended capillaries and vein endings of the mucous coat, into the portal vein. The motive power of the *vena portæ* is increased by active movement of the digestive tube (Heidenhain), and the course of the blood through the liver is accelerated. Thus laxative soda waters can do excellent service, not only when anatomical changes in the liver are the causes of the chronic hyperæmia of the digestive tube, and the

catarrh resulting from it, but also and especially in cases where the idiopathic catarrh has induced slowness of the circulation of blood in the capillaries and venous twigs of the intestinal tube. Many a cure, of what has been taken for a serious liver affection (about the diagnosis of which they are not very particular at many baths), is to be attributed to the removal of a disturbance of the local circulation, which has been caused by the chronic catarrh.

The recognised curative effects of soda waters (especially of the saline ones), in acute and chronic catarrhal jaundice, depend on the favourable influence they exercise on catarrh of the duodenum, and on the removal of the obstacle to the flow of bile, which was caused by the swollen state of the mucous membrane. Possibly there may also be the secretion of a thinner and more watery bile. Only the increase of secretion must be attributed to the water, and not to the soda; for Nasse's, Röhrig's, and Rutherford's experiments all agree in saying, that neither carbonate of soda, nor chloride of sodium, nor sulphate of soda, have any influence over the quantity of bile secreted, while copious drinking of water increases the amount of bile, and relatively diminishes its solid contents.

We cannot even at the present day explain thoroughly the fact, which has been proved a thousand times in public and in private practice, as well as at renowned baths, that saline soda waters assist the removal of gall stones. It has been attributed to the dissolving, stone-diminishing power of the waters, to the increased secretion pressure of the bile, which has been given off in larger quantity, and also to the reflex peristaltic action of the digestive tube, occasioning more active contraction of the gall bladder. As regards the solvent action of the waters, it is usually ascribed to an increased alkalescence of the bile, after their use. If this increased alkalescence has not yet been proved, yet, to negative such an assumption, we need not refer to the still defective proof of increased alkalescence of the blood after the use of soda; for it is always possible, that the soda brought by the *vena portæ* to the liver, may be at once made use of by the latter, for the formation of bile. It is also an indisputable fact, that cholesterin, and cholepyrrhin of lime are gradually dissolved in strongly alkaline bile, while gall stones,

which have a covering of carbonate of lime, can only be attacked by acids. Some have referred, in favour of the stone-dissolving and lithotriptic power of alkaline waters, to the fact, that the stones passed have often the appearance of having been eaten into. But stones, expelled spontaneously without soda waters, or after rhubarb or senna purgatives, have often the same appearance, and it is quite possible, that the corrosion or breaking into fragments may occur in the intestinal tube.

We know little of the action of the carbonates or sulphates of soda, when taken into the blood. The larger consequently is the field for balneological conjecture. It has been a bad habit in this branch of literature, with the object of giving 'exact scientific' accounts, to lump together the results of experiments made on dogs and frogs, by injecting salts of soda into the blood, without attending in the least to the quantities of soda used. Some have derived from 'therapeutic experience' other actions on the blood and change of tissue, and set them forth with an air of certainty, as if they were exact experiments, which on this subject are almost entirely wanting.

'It appears to be still very doubtful, whether we can produce any perceptible effect on the alkalescence of the blood by the employment of alkaline substances' (Buchheim). With its slow diffusibility, the absorption of carbonate of soda is slow, and its excretion is probably equally so. In this way, even considerable quantities of it may pass through the blood in a given time, without the alkalescence of the blood, which, according to Canard, may normally vary between 270 to 361 milligrammes in 100 cubic centimetres of blood, being materially altered.

Just as an observable increase of the alkalescence of the blood, after the use of alkaline water, has not yet been proved, (indeed, everything seems to point to the probability, that the small quantities of soda that are taken up, quit the blood immediately), so, on the other side, the objection, that strong alkalescence of the blood is prevented by the conversion of carbonate of soda into chloride of sodium and carbonic acid, has no force. In order to preserve the normal alkalescence of the blood, an amount of carbonate of soda, or of soda united to the bile acids, or of soda albuminates, must reach the intestinal tube, which is equivalent to any amount of hydrochloric

acid, which becomes free, in the gastric juice, from the chloride of sodium in the blood. If no carbonate of soda is taken in by the stomach, the hydrochloric acid of the stomach again unites itself with the soda of the intestines, and the chloride of sodium formed returns back to the blood. But if carbonate of soda is taken in by the stomach, then not only chloride of sodium is formed, which is taken into the blood, but the amount of carbonate of soda separated, which is equivalent to the production of hydrochloric acid in the stomach, passes back into the blood (Thiry). It temporarily increases the alkalescence of the blood in a small degree, but being superfluous, is soon excreted through the urine.

The most different effects on the blood, the change of tissue, &c., are attributed to this assumed increase of the alkalies of the blood. The carbonate of soda is supposed 'to diminish the amount of fibrine of the blood,' to 'increase the process of oxidation in the blood,' 'in larger doses to materially lower the oxidation of nitrogenous compounds, in smaller doses to increase the change of tissue, and operate as a diuretic,' &c. I look round me in vain for any proof of these assertions.

Starting from the fact, that many organic substances, foreign to the body, were more easily oxidised by the presence of alkali, some ascribed the supposed increase of the alkalies of the blood, after drinking soda waters, to an oxidation-increasing action. And this is appealed to even now, when attempts are made to explain the 'wonderful' effects of soda waters, in diabetes and in obesity.

But an increased combustion of fat, after drinking soda waters, has not yet been proved, although Scheremetjewski observed a slight increase of the excretion of carbonic acid, and of the consumption of oxygen, in rabbits, after injecting into their blood from 0·3 to 0·8 gramme of soda, neutralised with lactic acid. I may remind those who, on account of this experiment, are prepared to ascribe a similar operation to all salts of soda, that acetate and formate of soda (according to Scheremetjewski's experiments) have no such operation; and that the conclusion, that, because there may be an increased excretion of carbonic acid, there is also an increased combustion of fat, is not warranted.

The increase of the excretion of carbonic acid, and of the consumption of oxygen, may be occasioned by the rapid combustion of lactate of soda to carbonate, without there being necessarily a greater combustion of fat than usual (compare Voit, 'Zeitschrift f. Biologie,' vol. ix., 1873, p. 508).

There are no real grounds, therefore, for attributing the good results obtained in obesity, so especially at Marienbad and Tarasp, to an increased combustion of fat, excited by the alkaline contents of these waters. The explanation of those cures, is much more to be found in the strict diet, which forbids the use of alcoholics, of fats, of amylaceous food, &c., and confines the patient to a simple meagre table. To this is fortunately added the fact, that 'the use of a water cure at the place and site of the water, usually leads the most incorrigible sinners at table to a little self-reflection, and to at least a temporary repentance, because, very luckily for them, the most frightful stories of the bad effects of errors of diet, of overloading the stomach, &c., professedly observed by them, are in constant circulation among the frequenters of the place' (Immermann). Further, besides the increased bodily exercise, and other circumstances incident to cure life, an important part of the treatment of obesity is, the laxative action of the waters. The obesity usually diminishes the faster, the more active the purgative effects of the water are. By the purging, the full use (digestive and absorptive) of the nourishment taken is interfered with, fats and peptones are carried away, and the *well cure* becomes a mild *abstraction cure.* The results of the very late analyses of the urine by Zülzer, during the use of saline laxatives, deserve attention in this point of view, but no further. He found a relative diminution of phosphoric and sulphuric acids, of magnesia, of the chlorides of the urine, a diminution which is readily explained, by the incomplete assimilation of food in the digestive canal, by the carrying away of the fluids of digestion (the bile and pancreatic juice) caused by the action of the laxatives, of which last a great portion (bile sulphur, soda compounds, chlorine, iron, phosphoric acid) are, under most circumstances, reabsorbed in the digestive canal.

A specific operation in diabetes, was formerly attributed to the carbonate, and sulphate of soda of certain wells. As long

as Mialhe and Marchal's theory, that want of alkali in the blood was the cause of diabetes, and of the incomplete combustion of sugar, still found supporters, the explanation of the usefulness of soda waters appeared to be very simple. Mialhe's theory has long been given up, but it will be far more difficult to uproot the deep-rooted notion of the efficacy of Vichy and Carlsbad waters in diabetes. Little as it can be doubted, that, at these and other baths, many cases of diabetes are improved or cured, by a strict attention to antidiabetic diet, and by the other concurring incidents of a bath cure, as little can it now be maintained, that such favourable results, which constantly occur in private and in hospital practice, without the aid of waters, are to be ascribed to soda salts, or to mineral waters. Külz has shown, by a long series of experiments on several patients, that the use of Carlsbad water, has not the least power of diminishing the secretion of sugar in diabetics. Kratschmer, Kretschy, Riess, P. Guttmann, and others arrived at the same result. I have been myself for many years convinced of the uselessness of Carlsbad salts in diabetes, and have confined its use to cases only, where it was an object to overcome obstipation or stomach disorders. L. Riess has lately thoroughly examined and refuted certain objections that were made to Külz's experiments, on the balneological side of the question. Confirming Külz's results, he shows (1) that the Carlsbad water is not able, either in slight or in severe cases, to diminish the secretion of sugar in diabetics; (2) that, in some cases, the water is distinctly injurious, i.e. that the secretion of sugar is checked better and more quickly by diet alone, than in combination with Carlsbad water. From late experiments I find, that I can agree with Riess in his conclusions. Yet I have doubts, whether the salts held in solution in the Carlsbad waters act injuriously, i.e. favour the excretion of sugar, or whether it is the drinking of an increased amount of water, or the two together that do so. My experiments with increased water drinking, on diabetics, in whose diet no change has been made, have shown me, that the copious use of water has, in all my cases, been accompanied by a more copious excretion of sugar. This result was exactly the same, when I made various diabetics drink large quantities of distilled water for their thirst, making no change in their diet.

I do not consider it necessary to examine critically various phrases, which are in constant use in balneological writings, such as, the power of the carbonates of alkalies 'to keep the fibrine and the albumen in a state of solution in the blood,' 'the lowering of the process of change of tissue by the use of large doses of carbonate of soda,' 'the increase of products of retrogressive metamorphosis in the urine,' 'diminution of the amount of fibrine of the blood' by the use of alkaline waters. Usually such expressions, and many others, arise from entirely misunderstood results, or from naïve misapplications of physiological or of pharmaco-dynamical experiments and observations.

A peculiar influence on change of tissue, has also been ascribed to the sulphate of soda in these waters. Seegen thought that he had found, that the use of relatively small doses of Glauber salts lowered (even by 24 per cent.) the metamorphosis of tissue in the animal body. He further concluded, from the results of his experiments, that the Glauber salt increased the consumption of fat (from his observing a less increase of the weight of the body, than what corresponded to the diminished decomposition of albuminates). Voit, on the ground of exact experiments in change of tissue, in dogs ascertained to have the same weight of nitrogenous matter, attacked the correctness of Seegen's conclusions, and showed in a striking way, that the conversion of albuminates in the body was not influenced as Seegen had found (in doses of 3 grammes to a dog weighing 30 kilos.) On the contrary, further experiments showed, that Glauber salt and chloride of sodium produced an increased excretion of water, and with it increased decomposition of albumen.

According to Lehmann, alkaline bicarbonates, while they carry free supplies of carbonic acid to the blood, obstruct the complete oxidation of the uric acid, as well as of the derivatives of sugar-containing substances, and in this way favour the formation of oxalic acid. Beneke sees the chief factors of oxaluria, in the excess of alkaline bases in the blood, which is caused by the introduction of the carbonates of alkalies. Gallois finds, on the other hand, that bicarbonate of soda is the best means for removing the so called oxaluria. The long unproved assumption, that alkaline carbonates promote oxidation, has struck its roots deep. Thus I find the carbonated alkalies

strongly recommended in oxaluria, in a handbook, which has just appeared, of the pathology and therapy of the diseases of change of tissue. As this condition, as is usually supposed, depends on imperfect oxidation of uric acid, and of the derivatives from sugar, it is further concluded, that the alkalies do good, as they quicken oxidation. Fürbringer found, in his experiments with bicarbonate of soda, that it does not increase the excretion of oxalic acid through the urine.

The alkaline waters enjoy a deserved reputation in the treatment of various diseases of the uropoietic apparatus. We have shown above, that even in the case of the complete conversion of carbonate of soda in the stomach into chloride of sodium, the quantity of soda in the blood experiences a slight temporary increase. The bicarbonate of soda taken into the blood, and immediately afterwards excreted with the urine, neutralises the phosphate of soda of the urine, to which it gives a neutral or alkaline reaction. It is assumed, that the alkaline reaction of the urine, caused by the soda water, makes the mucus thinner, lessens the irritation of acid urine, and in this way, as well as by a direct favourable operation on the diseased mucous membrane, modifies for the better catarrhs of the pelvis of the kidney, of the bladder, and of the urethra. Medical experience supports the assumption ; only we must guard against ascribing to the alkalies a favourable action also on the causes of most bladder catarrhs, the elements of fermentation. These thrive rather better than worse, where there is alkaline reaction.

Alkaline waters are also a favourite prescription in gout, in the so called uric acid diathesis, in stones of the kidneys and bladder. The leading idea in this is, to promote the solution of the uric acid, which forms a sediment in the urinary passages, or to wash out to a certain degree the uric acid, which is stagnating in the tissues and juices. Possibly the increased current of water, and its diffusion through the tissues, aided by the solution of salts, promotes the oxidation of uric acid to its final products.

As regards the importance of alkaline waters in the treatment of stones of the kidneys and bladder, it cannot be doubted, that sediments or concretions of uric acid can be dissolved, or diminished in size, by the alkalies excreted through the urine ;

but, on the other hand, the increased alkalescence of the urine favours the dropping of earthy phosphates, and their deposit on uric acid stones, that may be present. As everyone knows, most kidney and bladder stones consist of a centre of uric acid, surrounded by a shell consisting of phosphates and oxalates of lime.

While uric acid stones demand the use of alkaline waters rich in alkalies, but not with very large amounts of carbonic acid, stones of phosphate or of carbonate of lime, on the other hand, point to an augmentation of the acid reaction of the urine, to the exhibition of acids, of acid salts, and of appropriate diet, &c. The introduction also of plenty of carbonic acid, is to be recommended in such cases, although it cannot dissolve stones already formed, because, if long employed, it increases the acidity of the urine, and thus retards the increase of the stone by fresh deposits.

On the contrary, the frequent recommendation of alkaline waters poor in carbonic acid, in the presence of oxalate stones, rests on the problematical theory of the combustion-increasing action of alkalies in the blood. By it some suppose, that the oxidation of uric acid (by the imperfect combustion of which oxalic acid arises) may be promoted up to the formation of urea, carbonic acid, and water.

If the gout depends (the uric acid diathesis) on an overloading of the blood (and the tissues) with uric acid salts, carbonated alkalies, in conjunction with copious water drinking, may have a favourable influence on it. It is believed, that the soda waters promote the oxidation of uric acid to urea, and in this way diminish the over-supply of uric acid throughout the system. There is not, however, a shadow of a proof for this assumption, which is so frequent in balneological books. We have not even yet got any proof, that soda waters in general (or when used in gout) increase the discharge of uric acid or of urea. Münch considers that he has seen diminution of uric acid up to 'disappearance of it' under the exhibition of carbonate of soda. He did not observe, whether the excretion of urea was increased at the same time. It is probable, that water taken in large quantities plays an important part in gout, as well as in lithiasis of the urinary passages, through its operation in washing out the tissues. There is a true idea lying at the bottom

of Cadet de Vaux's cure with warm water, in spite of its having been overdone. Whether gout depends on a diminished power of the kidneys to excrete uric acid, as Garrod once thought, or whether it arises from an increased formation of uric acid, and an accumulation of it in the blood ; whether it is caused by imperfect oxidation of uric acid, or by diminished alkalescence of the blood, in consequence of the presence of acids in it (paralactic acid ?), it is indifferent to us which of these theories is the right one ; we have not here to go into that question : yet each of them harmonises with the good effects of alkalies in gout, which is a matter of common experience. The catarrhs of the stomach (which are apt to commence with fermentation of the contents of the stomach and increased formation of acid), that often accompany or often induce an attack of gout, are combated successfully with alkalies and alkaline waters. The causal indication is often sufficiently fulfilled, by the properly timed employment of them, in the prodromi of gout.

What we have said of the diuretic action of acidulous waters, is equally true of soda waters. Chloride of sodium, carbonate and sulphate of sodium have a diuretic action, and on this also depends the temporary increase of the excretion of urea, which is observed when such waters are used.

The soda waters, naturally warm, or made so artificially, by the addition of milk or of whey, especially the muriatic ones, have become extraordinarily popular, as 'anticatarrhal, mucus-loosening, expectoration-promoting, and cough-soothing' remedies in catarrhal affections of the organs of respiration (of the larynx, and in acute and chronic bronchitis) ; no less so also, in the treatment of acute and chronic catarrh of the throat, angina, &c. The water is drunk, is inhaled, and is used as a gargle. Here we have simply to deal with a procedure which is approved by experience. No doubt warm water is the chief beneficial agent.

In the treatment of most of those diseases, the other matters incidental to a well cure are not to be undervalued.

Different alkaline waters are also used for baths. What we have said of warm baths in general, and of carbonic acid ones in particular, applies to these also. The overwrought descriptions of balneotherapists, have not convinced us in

the least, that the small quantities of soda present even in the strongest alkaline waters, when externally applied, have any action, except that of slightly stimulating the skin, swelling the epidermis, and saponifying any oil that is present. We also, for very good reasons, think it better not to go into the mysterious physiological and therapeutical components of the so named skin soothing (*Hautschmeichel*) of the soda waters.

Starting from the fact, that the dissolving power for uric acid of carbonate of lithium is much greater, than that of the other alkalies, the presence of lithium in some soda and chloride of sodium wells has led to their being assigned a special importance in the uric acid diathesis, in urinary concretions, and in gout. Nowadays many wells boast of their amount of lithium, or proclaim themselves in balneotherapeutics as 'richest lithium wells.' It is only a pity, that in all of them the amount of carbonate or of chloride of lithium (of the latter of which the uric acid dissolving power has still to be proved) is so small, that no therapeutic effect can be reasonably expected from them. It also has not yet been proved, that carbonate of lithium does absolutely increase the excretion of uric acid. If this remedy is to be used medicinally, or to the amount of about 1 gramme per diem, then its exhibition, dissolved in a carbonated water, or in Ewich's judiciously compounded soda lithium water (which contains in the litre 0·6 gramme of carbonate of lithium), or in Struve's lithium water (which contains 2·0 in the litre), is far more rational, than in a very large quantity of a natural water.

If we assume, on the foundation of Binswanger's experiments on the solubility of uric acid in carbonate of lithium, that the whole amount of lithium which is swallowed leaves the body combined with uric acid—certainly a very improbable supposition—then it follows, from such a conclusion, that even the waters richest in lithium must be drunk in unusually large quantities, if they are really to increase the excretion of uric acid. 1 part of carbonate of lithium is able to dissolve 3·6 parts of uric acid.

The following are the amounts of lithium present in the so called lithium wells in the 1,000 parts :—

The Bonifaciusquelle, in Salzschlirf . . .	0·21	chlor. lithium
„ Königsquelle, in Elster	0·1	carb. lithium
„ Ungemachquelle, in Baden Baden . .	0·04	chlor. lithium
„ Neue Quelle, in Dürkheim . . .	0·03	„ „
„ Sauerbrunnen, in Bilin	0·03	bicarb. lithium
„ Elisabethbrunnen, in Homburg . .	0·02	chlor. lithium
„ Rakoczy, in Kissingen	0·02	„ „

The well in Assmanshausen	0·03	chlor. lithium
,, soda lithium Quelle in Weilbach . .	0·009	carb. lithium
,, Struve's lithium water	2·0	,, ,,
,, Ewich's soda lithium water . . .	0·6	,, ,,

From the above table we may calculate, how many litres of the natural lithium waters must be drunk, to swallow a medicinal amount of lithium—say, 1 gramme per diem.

I may say a word here about the practice, which still prevails, here and there at baths, of boasting of the presence of minimal amounts of various substances in their waters. When many wells decorate themselves with the titles of muriatic, alkaline, earthy, saline, rich in iron, sulphur, iodine, bromine, lithium, even in arsenic, in silica, in argillaceous earth, without containing more than traces of these substances, the reason is, not that chemical analysis has shown their presence, for there are few waters that do not contain traces of many of them, but because it is thought that such titles aid their therapeutic reputation. I shall say nothing more about these empty titles and the motives for assuming them. Homœopathic balneotherapy has the same miserable foundation as homœopathy in general.

TABLE III.—*A.* THE ALKALINE WELLS (Acidulous).

(Contents in 1,000 parts of water; the carbonates of salts as bicarbonates free of water; temperature Fahrenheit.)

Name of Well	Situation	Bicarbonate of Soda	Chloride of Sodium	Sulphate of Soda	Free Carbonic Acid	Temperature
Rohitsch, Ignazbrunnen	S. Styria . .	8·6	0·3	—	348	55°·4
Vals, La Marquise .	Depart. Ardèche .	7·1	0·1	0·2	1,039	55·4
Passug, Ulrikquelle .	Switzerland . .	5·3	0·8	—	954	47·0
Vichy, Célestins . .	Depart. Allier .	5·1	0·5	0·2	532	53·6
,, Grande Grille .	,, .	4·8	0·5	0·2	460	105·8
Radein	Styria . . .	4·3	0·6	0·2	879	53·6
Fellathalquellen . .	Illyria . . .	4·2	0·2	0·5	609	46·4
Bilin	Bohemia . .	4·2	0·3	0·8	1,337	53·6
Fachingen . . .	Lahn Valley, Nassau	3·6	0·6	—	945	50·0
Preblau	Carinthia . .	2·8	—	—	637	50·0
Obersalzbrunn, Oberbr. .	Silesia . . .	2·4	0·1	0·4	630	44·6
Johannisquelle . .	Gleichenberg, Styria	2·3	0·5	—	755	51·8
Lipik	Slavonia . .	1·5	0·6	—	256	145·4
Giesshübel . . .	Bohemia . .	1·2	—	—	1,537	50·0
Apollinaris . . .	Ahr Valley (Bischof's analysis)	1·2	0·4	0·3	1,500	69·8
Geilnau	Lahn Valley . .	1·0	—	—	1,468	50·0
Neuenahr . . .	Ahr Valley . .	1·0	—	0·1	498	104·0
Struve's soda water .	—	2·0	—	—	3,000	—

B. Alkaline Muriatic Wells.

Name of Well	Situation	Bicarbonate of Soda	Chloride of Sodium	Sulphate of Soda	Free Carbonic Acid	Temperature
Szczawnica, Magdalenq.	Gallicia . . .	8·4	4·6	—	711	51°·8
Luhatschowitz, Johannesbrunnen	Mähren . . .	8·0	3·6	—	—	44·6
Luhatschowitz, Louisenbrunnen	,, . . .	7·3	4·3	—	—	44·6
Luhatschowitz, Vincenzbrunnen	,, . . .	4·2	3·0	—	1,452	44·6
Gleichenberg, Constantinquelle	Styria . . .	3·5	1·8	—	1,149	60·8
Tönnisstein, Heilbr. .	Brohl Valley, Rhine	2·5	1·4	0·1	1,269	50·0
Ems, Kränchen . .	Lahn Valley . .	1·9	0·9	—	597	96·8
,, Fürstenquelle .	,, . .	2·0	1·0	—	599	104·0
,, Kesselbrunnen .	,, . .	1·9	1·0	—	553	116·6
,, Römerquelle .	,, . .	2·1	1·0	—	525	111·2
,, Neue Badequelle .	,, . .	2·0	0·9	—	448	122·0
Weilbach, soda lithium well	Nassau . . .	1·3	1·2	0·2	151	53·6
Royat, Source Eugénie .	Auvergne . .	1·3	1·7	0·1	379	95·0
Selters	Nassau . . .	1·2	2·2	—	1,149	60·8
Roisdorf . . .	Near Bonn . .	1·1	1·8	—	726	51·8

C. The Alkaline Saline Wells.

Name of Well	Situation	Sulphate of Soda	Bicarbonate of Soda	Chloride of Sodium	Free Carbonic Acid	Temperature
Elster, Salzquelle . .	Saxony . . .	5·2	1·6	0·8	986	48°·2
Marienbad, Ferd.-Br. .	Bohemia . .	5·0	1·8	2·0	1,127	48·2
,, Kreuzbr. .	,, . .	4·9	1·6	1·7	552	50·0
Franzensbad, Kalter Sprudel	,, . .	3·5	0·9	1·1	1,576	50·0
Franzensbad, Salzquelle	,, . .	2·8	0·9	1·1	831	50·0
Karlsbad, Mühlbrunnen	,, . .	2·3	2·0	1·0	180	125·6
,, Sprudel .	,, . .	2·3	1·9	1·0	104	158·0
,, Schlossbr. .	,, . .	2·2	1·7	0·9	483	122·0
Tarasp, Bonifaciusq. .	Engadine . .	2·2	1·4	—	1,026	46·4
,, Luciusquelle .	,, . .	2·1	5·4	3·6	1,060	42·8
Rohitsch, Tempelbr. .	Styria . . .	2·0	1·0	—	1,129	50·0
Bertrich . . .	Coblenz . . .	0·9	0·2	0·4	120	87·8
Fuered, Franz-Josephq.	Hungary . .	0·7	0·1	—	1,370	50 0

4. THE BITTER WATERS.

(See Table IV.)

Mosler: 'Ueb. d. Wirk. d. Friedrichshaller Bitterw.' Marburg, 1860.—Id.: *Archiv d. Ver. f. gem. Arb.*, 1860, vol. v.—Duhmberg: 'De Effectu Magnes. Sulphat.' Inaug. Dissertat. Dorpat, 1856.—Seegen: l.c.—Voit: l.c.—Buchheim: 'Arzneimittellehre,' 3rd edit. p. 130.—Zülzer: l.c.—Mering: 'Stoffwechsel beim Gebr. d. Friedrichshaller Bitterwasser,' *Berlin. klin. Wochenschr.*, 1880, No. 11.

The bitter waters follow the Glauber salt alkaline waters naturally, as they always contain, besides their chief constituent, sulphate of magnesia, a large supply of sulphate of soda, and do not in reality differ from them in their physiological action and therapeutic indications. Their chief action, especially in a therapeutic point of view, is their purgative one.

Most of the waters of this class are distinguished for the high cipher of their solid constituents, and all of them are cold wells.

While the sulphate of soda is only slightly decomposed in the intestinal canal, a small quantity of its sulphuric acid combining with the potass in the intestinal canal, the sulphate of magnesia, according to Buchheim, undergoes greater changes. When it remains long in the intestinal canal, a part of its sulphuric acid is taken from the sulphate of magnesia by the soda and potass present, while the magnesia, combined with the decomposition products of the bile, remains behind in the intestine. By its continued stay there, a part of the sulphated salts is reduced to sulphide, which is afterwards decomposed by the carbonic acid, and perhaps also by other acids of the canal. Hence the frequent generation of hydrosulphuric acid in the intestines, when these waters are taken. If the bitter water acts rapidly as a purgative, the greatest part of the sulphate of magnesia leaves the digestive canal in this way, unaltered. What is taken up by the blood, is immediately excreted again through the urine. As to the mode of operation by which sulphate of magnesia acts as a purgative, what we said above of Glauber salt applies to it. Although its chief action may be in promoting the peristaltic action of the canal, still there is much to be said for the view, that the sulphates promote

diarrhœa by increasing the secretion of the fluids of the intestinal canal. Frerichs speaks recently of bitter salts 'fluidifying its contents, by causing an increased secretion from the glands of the intestinal canal.' According to Rutherford, sulphate of soda has but insignificant influence on the secretion of bile. Probably much is not to be expected from sulphate of magnesia either, in this direction.

The motions which follow the use of bitter waters are watery, generally dark coloured, contain little mucus and no albumen. Bitter waters are counted among the milder laxatives, which operate without pain, 'colic or tenesmus,' and which may be continued to be used for long periods, without being injurious. But there are frequently exceptions to this. The operation is generally prompt, but the minimal dose that will operate varies much with the individual. As in the case of all laxatives, a certain degree of the system getting habituated to them comes on, after they have been used for some time, so that in the end large doses, which at the beginning of the treatment would have acted violently, require to be used.

It is a simple matter of experience, that in some cases of defective activity of the digestive canal, the bitter waters are not borne well. I have often found this, especially in anæmic and weakly individuals, in convalescents, and in patients with tuberculous ulceration of the bowels; I avoid them also in the constipation of fever patients, in the first stage of convalescence from inflammation of the cæcum, and in chronic peritonitis.

On the other hand, one often sees most excellent results follow from the continued use of these waters in simple chronic catarrh of the bowels, or in the habitual constipation of hypochondriac or of hysterical patients, or of persons of sedentary habits, dependent on 'nervous atony' of the bowel. If these waters are used at their source, no doubt their effects are aided by the many factors of a cure, which we have so often enumerated, but most of these factors can be had at home, along with a systematic use of the waters. (Practically speaking, patients are seldom sent to such waters for treatment; indeed, many of their sources have no accommodation for them.—*Tr.*)

There is no question that the sulphate of magnesia and of soda waters may often, by their power of exciting peristaltic action (see above, pp. 358, 359), prove useful in their influence on the

circulation of blood through the liver and the intestines. In spite of the stock phrases of 'abdominal plethora,' 'obstruction of the liver,' 'stoppage of the veins of the lower bowel and of the *vena portæ*,' there is in fact a great deal of truth in them, if the physiologically thinking physician will select only the real, and resolve those phrases into their true physiologico-pathological elements.

Powers of limiting the conversion of tissue, and of diminishing the excretion of uric acid, have been attributed to sulphate of magnesia, as they were to sulphate of soda (Seegen). Voit demolished those views, as we have already seen, with reference to sulphate of soda, and in this respect the two salts are probably alike.

As the bitter waters, by means of their purgative action, aid the removal of the matters of nutrition (peptones, fats, salts, &c.) from the intestinal canal, they act as diminishers of nutrition, and if the *minus* carried away is not replaced by the use of a *plus* of nutritious substances, it is not surprising to find that the weight of the body diminishes, and the fat of the abdomen shrinks away, during a bitter water cure, in which the diet is strictly regulated.

The frequently increased demand for nourishment, which is shown by an improved appetite, results from the abstracting power of the bitter water.

J. v. Mering has very lately studied the influence of the Friedrichshall bitter water on the conversion of tissue, during an experiment of three weeks, with persons during the treatment taking the same food and living alike. Although during the use of the bitter waters 2 to 3 motions occurred daily, which contained three times as much fæces as during the days when the waters were not used, yet on all the days of the use of bitter water—the first day excepted—the quantity of urea in the twenty-four hours was greater than on the days when the water had not been taken. The increase of urea was 8 per cent. Mosler had arrived at the same result, for this observer discovered an increase of 6 per cent. of urea during the daily use of 250 grammes of bitter water.

The quantity of uric acid was lessened in Mering's experiment, which agreed with the older results of Heller. On the

other hand, the phosphoric and sulphuric acids, and the excretion of chloride of sodium, were considerably increased. (Compare with this Zülzer's results, given above, and which point in a different direction.) We must conclude, from our present knowledge of the effects of sulphate of soda and of sulphate of magnesia, that in Mering's experiments the chloride of sodium had an important share in the admitted conversion of tissue.

Voit had observed a slight increase of the quantity of the urine from the use of sulphate of soda; Mering obtained the same result from that of the Friedrichshall bitter water. Only he is in error when he believes that Seegen had previously discovered an increased conversion of the albuminates, under the use of Glauber salt. On the contrary, Seegen, as is known, asserted a diminution of the conversion of albuminates, under the use of Glauber salt. The sulphate of magnesium, indeed, does not fail to act on the albuminates, as had formerly been supposed, but, like chloride of sodium, sulphate of soda, and other neutral salts (Voit), produces increased discharge of water, and as a consequence increased decomposition of albumen.

TABLE IV.—THE BITTER WATERS.

(Constituents in 1,000 parts of water.)

Name of Well	Situation	Sulphate of Magnesium	Sulphate of Soda	Chloride of Sodium	Chloride of Magnesium	Total
Franz-Joseph-Bitterquelle	Buda Pest . . .	24·7	23·1	—	1·7	52·2
Birmenstorff . . .	Aargau, Switzerland .	22·0	7·0	—	—	31·0
Hunyadi János . .	Ofen, Buda Pest . .	16·0	15·9	1·3	—	35·0
Sedlitz	Bohemia . . .	13·5	—	—	0·3	16·4
Püllna	,, . . .	12·1	16·1	—	2·4	32·7
Saidschütz . . .	,, . . .	10·9	6·0	—	0·2	23·2
Montmirail . . .	Dep. Vaucluse . .	9·3	5·0	—	0·8	17·1
Galthofer . . .	Near Brünn in Mähren	7·1	4·8	0·2	—	13·8
Mergentheim, C. B.-Wass.	Würtemberg . .	5·4	6·6	16·1	—	31·0
,, Carlsquelle	,, . .	2·0	2·8	6·6	—	13·9
Friedrichshall . . .	Saxe Meiningen . .	5·1	6·0	7·9	3·9	25·2
Kissingen, B. Bitterquelle	Bavaria . . .	5·0	5·8	7·6	3·8	25·2
Unter-Alap . . .	Hungary . . .	4·0	18·1	14·4	—	37·6
Ober-Alap . . .	,, . . .	3·1	5·7	4·1	0 9	16·5
Kis-Czég . . .	Siebenbürgen . .	3·1	13·1	1·4	—	18·8
Ivanda	Banat, Austria . .	2·4	12·4	2·3	—	21·4
Grossenlüder, Hessian bitter water	—	1·3	—	15·4	—	21·9

5. CULINARY SALT WATERS.

HALOPEGÆ, HALOTHERMALS, SALT FOUNTAINS, SALT THERMALS.

(See Table V.)

Kaupp: *Archiv d. Heilk.*, 1855, p. 407.—L. W. Bischoff: 'Der Harnstoff als Maass d. Stoffw.,' 1853.—Beneke: 'Ueber Nauheim's Sooltherm. u.s.w.' Marburg, 1859.—Id.: 'Ueber d. Verhalt. d. Puls., d. Respir. beim Gebrauch d. warm. Soolb.,' *Archiv d. Ver. f. gem. Arb.*, vol. iv. p. 127.—Id.: 'Zum Verständniss d. w. Soolbadwirk.,' *Berl. klin. Wochenschrift*, 1871, No. 27.—Voit: 'Uber d. Einfl. d. Kochsalz u.s.w. auf d. Stoffwechsel.' Munich, 1860.—Kemmerich: *Pflüger's Arch.*, vol. ii.—Forster: 'Ueber d. Beding. der Aschenbestandth. in d. Nahrung,' *Zeitschr. f. Biologie*, 1873, vol. ix.—Klein and Verson: *Sitz.-Ber. d. k. k. Akad. d. Wissensch. z. Wien*, 1867.—Binz: *Deutsche Klinik*, 1873, No. 48.—Santlus: 'Ueber d. Einfluss d. Chlornatr. Bäd. auf d. Hautsensibil.' Dissert. Marburg, 1872.—Siegmund: 'Ueber künstl. Soolbäder,' *Berlin. klin. Wochenschr.*, 1875, 2 and 3.—Röhrig: 'Ueber d. Indic. d. jod- und bromhalt. Soolquell.,' *Berlin. klin. Wochenschr.*, 1875, No. 46.—Diruf and Niebergall in 'Valentiner's Handb. d. Balneotherap.,' 2nd edit. p. 154 ff.

The springs belonging to this group, are distinguished by containing more or less chloride of sodium, which is their predominating constituent. Besides it, they contain other combinations of chlorine in various proportions, which are not important either physiologically or therapeutically, such as chloride of calcium, chloride of magnesia, chloride of potass, also small quantities of chloride of lithium, and of chloride of aluminum. Some of the salt springs are distinguished for containing universally small amounts of iodine and bromine (iodide and bromide of soda, potass, calcium, magnesia), the so named *iodine and bromine salt springs*; others contain a good deal of earthy salts, as sulphate of lime, or carbonate of lime and magnesia, and are termed *earthy salt springs*; again, others contain sulphate of soda, or of magnesia, and are called *saline salt springs*. Several of them are distinguished by an abundant supply of carbonic acid, the *salt acidulous waters*, while, finally, some have an amount of iron worth mentioning, and are called *chalybeate salt waters*. We have both cold and warm salt wells (salt, and strong salt, brine or *sool* thermals).

Several of the alkaline Glauber salt and sulphate of magnesia wells, just described, contain a large amount of chloride of sodium, which of itself is enough to give them the name of salt waters. We, on the other hand, count many springs salt ones, which contain less chloride of sodium than some of the bitter waters do, for instance, Friedrichshall, and we do so, because chloride of sodium is their chief constituent.

The amount of chloride of sodium is very variable, and ranges from 1 to 25 per cent. It is usual to distinguish between simple salt waters and brines, by the amount of chloride of sodium which they contain. Under the latter term, one understands salt waters which, owing to their considerable amount of salt (at lowest 1·5 per cent.), arise either direct from the soil or through bored channels, and are either naturally strong enough for baths, or become so after artificial concentration.

The strongest brines contain more than $\frac{1}{5}$ of their weight in salt. There are 20 to 31 per cent. brines, for instance, Reichenhall with 23·5 per cent., Hall on the Inn with $25\frac{1}{2}$ per cent., Jaxtfeld with $25\frac{1}{2}$ per cent., Salzungen with 26, and Rheinfelden with 31 per cent.

The brines are chiefly used for baths; the weaker salt waters, which contain less than 1 per cent., are employed for drinking. But salt water cures are also in use at places where there are only brines, as the necessary dilution of such waters is made with water, milk, or whey. Again, in other places, where the brines are scarcely strong enough for bathing, they are fortified by concentration. And even in places where that is not the case, as in Baden-Baden, Homburg, Wiesbaden, &c., simple salt water baths may, if necessary, be converted into strong ones, by the addition of rock salt, or of the 'soolen' which are widely exported, or by the 'mother leys,' or by 'bath salts,' which are very expensive, and might well be dispensed with.

Culinary Salt Drinking Cures.

Pure drinking cures are seldom used at the salt springs, either hot or cold; the use of brine baths is commonly associated with drinking. If we assume that the quantity of a salt water swallowed daily is 1 litre—more is only drunk exceptionally—the quantity of chloride of sodium taken in, at highest, and supposing one of the strongest salt springs to be used, may be 15 grammes; or if we include other chlorides, which are often present, and also calculate on the strongest salt springs, (say)

16 grammes in all of chlorine compounds. The normal average daily consumption of 20 grammes of chloride of sodium is thus raised by the help of the salt springs to 35 grammes, an increase which is not unusual under the common circumstances of life, or under the use of various kinds of food. But in most drinking cures, not one half of the amount mentioned above is taken.

Chloride of sodium, when it has reached the stomach, strongly stimulates the secretion of the gastric juice, which is increased by it, as experiments with fistulas in the stomach have shown. The salt is also believed to favour the formation of peptone (only indeed when there is a certain fixed percentage of chloride of sodium in the contents of the stomach), and further to accelerate the absorption of peptone. These effects of salt are appealed to, when salt waters are recommended in various conditions of disordered digestion, in anorexia, dyspepsia, chronic catarrh of the stomach, &c.

In like manner, salt reflexly excites the peristaltic action of the stomach, and furthers the removal of the contents of the stomach, or of their stagnating remains in the intestinal canal. Hence the recommendation of salt water in atony of the stomach, in dilatation of it, with or without narrowing of the pylorus.

Owing to the great diffusibility of salt, a large portion of it is at once absorbed in the stomach. What reaches the intestines, excites their peristaltic action also. The stronger salt waters, and the weaker ones drunk in large quantities, owe the greater part of their effects to this purging action. In this point of view, as regards the curative indications for the use of salt waters, they are really the same, as those already assigned to the Glauber salt and Epsom salt waters. It is for their purging operation that they are recommended, in chronic catarrh of the intestines, in habitual constipation, in atony of the intestinal canal, in certain forms of obstruction of the portal system, in the treatment of obesity, &c. The purging effect of the salt water is assisted in some springs, both by the presence of some other chlorine compounds, and also by the two purging sulphates.

The absorbed chloride of sodium reappears immediately in the urine, the amount of chlorides in which is thereby increased. Yet, as the experiments of Barral, Kaupp, Voit, and Feder

show, some chloride of sodium is retained. As much as four days passed with a dog kept starving, before the increase of the excretion of chloride of sodium, caused by the increased quantity of that salt which had been given him, fell back to its former amount. In a dog which was sufficiently nourished, and with an equipoise of nitrogenous matters, chloride of sodium given in excess was excreted a little more quickly than when the dog was starved, but it was always three to four days, before all the salt that had been taken in, appeared again in the urine. Salt acts as a slight diuretic (Voit).

The chloride of sodium, taken into the stream of the circulation in increased quantity, developes an operation physiologically most interesting. If one increases the supply of chloride of sodium within certain limits, the excretion of nitrogen through the urine increases. Voit has established this fact, which was previously indicated by Bischoff's and Kaupp's researches, by a series of exact experiments on conversion of tissue. According to Voit, this action of chloride of sodium is caused, by its increasing the celerity of diffusion of the current of fluids through the parenchyma, so that larger amounts of the circulating albumen are exposed to the breaking-up powers of the cells.

Bath practitioners make the fullest use of this important physiological fact, and of its explanation, in expounding the curative effects of the salt waters, as well as in laying down indications for their use. The salt waters, they say, 'powerfully excite the conversion of tissue,' hence their favourable operation in 'general plethora,' in 'over-nutrition,' and in obesity, &c.

While the salt waters promote the circulation of the fluids, also through pathological products, plastic, and other formations, they loosen their structure, carry away their albuminates, and favour their combustion; along with this, fat is formed in the pathological products, which now can easily be absorbed. On this is based the theory of the curative effects of salt waters in scrofulosis, with its many exudations, and hyperplasias of the glands; on this rests the theoretical indication for the use of these waters, in the most various exudations of different organs, especially in chronic infarction of the uterus, in chronic exudations of the pelvis, in peri- and parametritis, &c.

It is obvious, that such an application of the known physio-

logical effects of chloride of sodium to pathological conditions, cannot be accepted without further inquiry. The increase of the excretion of urea, after augmented use of salt, divides itself over the whole system, over all the sources of formation of urea, and does not exclusively, or in a chief degree, act on the pathological products, many of which are indeed distinguished by their very slight conversion of tissue, and by the slow movement of their fluids.

Chloride of sodium is, as Forster's experiments have shown, an important constituent of nourishment, which cannot be dispensed with for any length of time, which, as Liebig explains, plays a part in the building up of organs, as well as in the metamorphosis which takes place within the fluid and solid textures. Voit announces as a further property of salt, that it influences the solubility and the diffusibility of albuminous matters. On these no doubt correct conclusions of the physiologist, balneotherapists ground the important therapeutic effects of the salt waters. To use their modes of expression, salt waters 'stimulate and heighten the plastic activity of the organism,' 'facilitate the formation of cells,' 'increase the number of the blood corpuscles,' 'lower the amount of water and albumen of the blood,' and as these waters, as we said above, at the same time increase the combustion of albuminates, they should possess the remarkable property of regenerating the whole organism, of purifying it from injurious dross, and of renewing its youth. The problem of Medea would thus be solved in the simplest way, by salt waters. Diruf pointed out as a fact, 'which could not be sufficiently proclaimed,' in a therapeutical point of view, that a 'moderately increased supply of chloride of sodium is able, under certain conditions, to induce, along with accelerated conversion of nitrogenous tissues, an excess of formative over removing action in the system, and in other cases, to reverse the process.' Certainly a very convenient, if not a very clear theory, for explaining the efficacy of salt waters in the most different forms of disease, a fact which cannot be empirically gainsaid.

Chloride of sodium is said to 'increase the secretion of various mucous surfaces,' and especially that of the organs of respiration. It is said to act as an 'anti-catarrhal,' as a 'solvent

of mucus,' to 'regulate the nutritive condition of the affected mucous membrane,' &c. Hence the recommendation of these waters in catarrh of the respiratory organs; the lion's share of the empirically proved efficacy of these waters, in such affections, is no doubt to be ascribed to their warmth.

The 'iodine and bromine salt springs' put forth still higher pretensions. The belief that iodine or bromine is absorbed by the skin in baths of such waters, still maintains a lingering existence in some balneological writings. But it is otherwise with the assumption, that iodine and bromine act as 'powerful absorbents,' when drunk in these waters. As people formerly talked of the amount of iodine in cod-liver oil (which is said to contain about 8 milligrammes of iodine in the spoonful), so people nowadays ascribe to the iodine and bromine contents of salt waters a specially curative influence in the treatment of scrofulosis, uterine infarctions, exudations, &c. In this it is tacitly assumed, that iodine and bromine are completely alike in their physiological and therapeutic actions, an assumption which is totally erroneous. For we only know of the definite action of bromine, indeed only of bromide of potass, on the nervous system, an action, too, requiring large doses which exceed a hundred and a thousandfold the contents of the strongest bromine spring. We must, therefore, regard the often bepraised bromine contents of waters as being entirely beside the question. And it is not much better with the amount of iodine, which is so small, even in the 'strongest iodine springs,' that it requires the credulity of a homœopath, to talk of the iodine action of such springs.

A patient who drinks even a litre of the Adelheids well daily, takes up 0·028 of a gramme of iodide of soda, an amount from which any iodine action is certainly not to be expected. People have begun, therefore, to add 'spring salt' to the waters of some of the iodine sources; but a simple calculation shows, that even then, the amount of iodine is not increased sufficiently to be operative. And if all the good effects are expected from the iodine, would it not be simpler to add iodide of potass? The absorbent power of the iodine and bromide salt waters is not denied; only we have to thank for this, not their iodine or bromine, but their warm water and their chloride of sodium, and on

this account we do not separate them from the ordinary salt waters.

The following table, of the iodine contents of the most praised iodine salt springs, ought to place their supposed action in a proper point of view. It is taken partly from Niebergall's paper in Valentiner's 'Handbook of Balneotherapy.' The contents are in the 1,000 parts—

Salzburg	Hungary	0·25	iodide soda
Zaizon	Siebenbürgen	0·24	,, ,,
Castrocaro	Tuscany	0·19	,, ,,
Saxon les Bains	C. Wallis	0·11	iodide, calcium, and magnesium
Hall	Upp. Austria	0·04	iodide magnesium
Baassen	Siebenbürgen	0·03	iodide soda
H. Adelheidsquelle	Bavaria	0·02	,, ,,
Wildegg	C. Aargau	0·02	iodide magnesium
Lubatschowitz	Mähren	0·02	iodide soda
Sulza	Thuringia	0·02	,, ,,
Lipik	Slavonia	0·02	,, ,,
Königsdorff	Upp. Silesia	0·01	iodide magnesium
Iwonicz	Gallicia	0·01	iodide soda
Salzbrunn	Silesia	0·01	iodide magnesium
Goczalkowitz	Upp. Silesia	0·01	,, ,,
Salzschlirf, T.-B.	Near Fulda	0·005	,, ,,
Dürkheim, B.-B.	Palatinate	0·001	iodide soda
Krankenheil	Bavaria	0·001	,, ,,
Kreuznach, E.-Q.	Nahe Valley	0·001	iodide magnesium
Ewich's iodo-sodo-salt water	—	1·3	iodide soda
Ewich's iodo-lithio-water	—	0·9	,, ,,

The preceding table shows the actual facts, respecting the springs that have assumed the title of 'iodine and bromine containing.' This title, current in popular speech, and constantly repeated in newspaper bath announcements, has induced many practitioners to have such implicit faith in these waters, that they consider it unnecessary to instruct themselves as to the quantity of iodine which they really contain. It is only thus that I can explain various experiences. If, for instance, a patient is sent from Colberg on the Baltic, which itself possesses an excellent brine, to Kreuznach, this may perhaps be judicious on climatic and other considerations. But if such medical advice is given, on the idea of the curative effects of the iodine or bromine of Kreuznach, it is a mere illusion. It is equally one also, if a patient who has been ordered to Reichenhall, to support his brine cure with a mountain climate, is directed from another quarter to proceed to Koruznach 'because the iodine and bromine there are

specially favourable in scrofula.' We also observe many delusions in the prevalent beliefs in the specific virtues of the particular 'mother liquors' which are often dispatched to great distances.

Salt Baths.

An amount of 2 to 3 per cent. of chloride of sodium (or 12 to 18 lbs. of salt in an ordinary bath of 300 litres of water) constitutes a brine bath of middling strength. This amount is not often exceeded; even where strong brines exist, it rises at most to 8 or 10 per cent. We commence with weaker baths of 1 to 1½ per cent. when there is an irritable skin, and with children. In places where the natural water is too weak, it is strengthened by the addition of concentrated brine, or also of 'mother liquor.'

Salt water baths exercise a smaller or greater stimulation on the skin, according to the amount of salt which they contain. 'This state of excitement of the sensory nerves of the skin propagates itself to the central parts of the nervous system, to the brain, the medulla oblongata, the vertebral column, and here reaches and influences the centres of circulation, and respiration, of conversion of tissue, of the supply and of the abstraction of heat, the secretion of the glands, the movement of the lymph, the secretion of urine,' &c.

The brine bath occasions in the first place a temporary contraction of the cutaneous vessels, which is followed by a considerable expansion of them. The skin, which is at first pale and chilly, is covered with a diffused redness, and does not return to its normal state till some hours afterwards (Röhrig). We cannot doubt, that changes in the circulation and general distribution of the blood, may be produced by a process of this kind, which occurs also in a less degree in every simple bath of the temperature, or over the temperature, of the skin. A strong warm brine bath is a derivative, in so far as it temporarily frees the organs of the interior of a certain amount of blood. Whether in this way, we can influence local chronic hyperæmias of the internal organs, is a quite different question, the reply to which depends chiefly on this, whether the chronically dilated vessels of the affected hyperæmic organ have a tendency to

contract in the same degree as the vessels of the surface expand, an assumption which has not yet been proved.

'The primary contraction of the vessels in a brine bath is accompanied by an increased frequency of the heart's contractions, probably also, with a slight increase of the blood pressure. The expansion of the peripheral arteries, is followed by a retardation of the heart's contractions, and by a lowering of the blood pressure.'

This explanation, which is more theoretical, than proved experimentally, still requires to be established by proof. The same remark applies to the assumptions, which assign to salt baths a varied reflex power of influencing the centres of the innervation of the heart.

The influences on the centre of respiration are various. The rule seems to be, a slight retardation of the respirations. Whether the respirations become deeper at the same time, and how the volume of breath is affected, is quite unknown. (Compare what was said above about this question.)

We must guard against applying, without further consideration, to the action of brine baths on men, experiments which have been made, with mustard poultices, rubbing in spirits of mustard, and other painful irritants, on the shaved skin of rabbits.

According to the remarks of Santlus and Beneke the sensibility to touch of the skin is increased by brine baths.

As a further reflex effect of the stimulation of the skin produced by salt baths, it is said that the secretion of the various juices of digestion is increased. From this come the 'increased appetite' or 'the relieved assimilation,' &c. We need scarcely allude to the rough hypothetical nature of such explanations.

'The brine baths excite diuresis, and further call forth reflexly contractions of the bladder; hence the inclination to make water during the brine bath, or immediately after it.' But the same action is ascribed to simple, to indifferent warm, as well as to hot and cold baths. It remains undecided, whether in all these cases, the chemical or the thermal stimulation of the skin, is the cause of the occurrence.

The 'powerful influence of brine baths on conversion of tissue,' which is so often brought in, to explain therapeutic effects, is a question of more importance. Beneke finds that an

increase of the conversion of albuminates takes place under the use of brine baths, and that the daily increase of the excretion of urea amounts to from 1 to 2 grammes. The increase of urea is here accompanied by a decrease of uric acid. Further, Beneke found the excretion of phosphates, and especially of the phosphate of lime, lessened, as so often occurs when tissue change is accelerated. If positive conclusions, as to the increased decomposition of albuminates, during the use of brine baths, are to be drawn from so slight an increase of the amount of urea excreted in the twenty-four hours, as lies within the ordinary variations of it, it is pressingly required, that the conditions observed by Voit and Pettenkofer in their pattern experiments on conversion of tissue (I mean, making the experiments on persons who are circumstanced alike as to amount of nitrogenous matter), should be pursued scientifically. As long as this is not the case, even long-continued series of experiments yield at most only probable conclusions.

As the simple water bath of indifferent temperature is said not to have the power of increasing urea, this power of the brine baths is ascribed to the chloride of sodium and the other chlorides, which are supposed to cause an increased conversion of the albuminates by reflex action.

Röhrig and Zuntz, in their researches concerning the influence of brine baths on the excretion of carbonic acid, and on the taking up of oxygen, came to the conclusion, that both were increased by them. They found in a 3 per cent. bath of the temperature of 96·8° an increased consumption of oxygen amounting to 15·3° per cent., and a greater excretion of carbonic acid by 25 per cent., as compared with an ordinary water bath of the same temperature. These authors consider that there is an increased conversion of nitrogenous compounds. Paalzow found after the application of irritants to the skin of rabbits, both the excretion of carbonic acid and the consumption of oxygen increased. He could not, however, observe any such effect from a bath rich in carbonic acid.

The influence of brine baths, on the conversion of albuminates, as well as of fats, which is inferred from these experiments, forms the basis on which numerous explanations of the good effects of brine baths in disease are founded. The

favourable effects of these baths in scrofulosis, in rachitis, in chronic exudations, and residuary effects of inflammation (in pelveoperitonitis, perityphlitis, old pleuritic exudations, chronic joint exudations, &c.), in hyperplasia of the lymph glands, in chronic metritis, oophoritis, prostatitis, mastitis, &c., are empirically established. The favourite explanation of all these effects, is to attribute them to the agency of the brine baths, in increasing conversion of tissue, in which also a more direct reflex action of the stimulated cutaneous nerves on the processes of absorption (increased movement of lymph, increased power of absorption, &c.), is assumed. The increased 'conversion of tissue,' favours in the first place, as Niebergall believes, 'the quicker removal of exudations.' A rather different train of thought is expressed by Röhrig: the most different chronic diseases are remarkable for 'a retardation of tissue change.' Skin-stimulating salt baths show their beneficial action on this general falling off of 'the natural tissue change,' by exciting it afresh. The products of disease, exudations, plastic deposits, are drawn into this 'physiological increase of the combustion of the inner tissues.' As the degree of the 'excitement to tissue change,' is proportionate to the strength of the stimulation of the skin, a scale of the different brine and other skin-stimulating baths may be constructed according to their richness in salts and carbonic acid. It seems to me scarcely necessary that I should say, that the foundations of the whole of this salt bath theory are very weak. Only complete experiments in tissue change, conducted according to the exact methods of Voit and Pettenkofer, can settle the question. Such experiments, so far as I know, have not as yet been made.

The brine baths also boast their powers in several chronic exanthemata. Undoubtedly baths alike, whether they are of common warm water, as house baths and indifferent thermal ones, or whether they contain chloride of sodium, soda, lime, sulphur, exercise a favourable influence in certain forms of chronic exanthemas. They soften, macerate, and cleanse the scales and crusts of the epidermis; they may thus stimulate the production of healthy epidermis, and improve the functions of the skin. But the idea of a specific action of brine, sulphur, or alkaline baths in certain skin diseases, is pure illusion. The

law which Hebra lays down about prurigo, that a patient suffering from it may find relief from any bath, whatever its constituents may be, if only he remain long enough in it, applies also to many other chronic skin affections. Warm baths, whatever salts or gases they may contain, are beneficial in many cases of psoriasis, hyperidrosis, seborrhœa sicca, furfuracea, in pityriasis versicolor, urticaria chronica, and in convalescence from acute exanthemata, in scleroderma, in ichthyosis, &c. Long-continued baths, of several hours' duration, are particularly useful in these diseases, as the waters of Leuk, in which one need not regard the amount of lime present. On the other hand, it is well known by experience, that in most eczemas, especially in the moist, papular, vesicular, and impetiginous forms, E. rubrum squamosum, all skin-irritating baths, such as the brine baths, are contraindicated. Yet it cannot be denied that brine and various other baths may be of some use in scrofulous eczemas, by influencing favourably the nutrition of the patient, his anæmia, and scrofulous dyscrasy.

The other chlorides, and salts, and especially the carbonic acid, present in many of these salt baths, increase their stimulating effect on the cutaneous nerves. It is a matter of no importance whether the stimulation is effected by chloride of sodium, or by an equivalent amount of chloride of calcium or of magnesia; by carbonate of iron, or by carbonic acid. There is not a shadow of a proof that those substances, any more than salt, have a specific action on the skin.

We must judge from this point of view the use of the 'mother lyes' which are sent such distances. They serve solely to make the bath more concentrated, and can be completely replaced, by the addition of an equivalent amount of the far cheaper artificial salt, the *Vieh* (cattle) salt. If some of the mother lyes are remarkable for containing iodine or bromine, this may be interesting to the chemist: to the physician, it would be a matter of indifference, were the amount of iodine ten times as great, for there now can be no idea that this substance can be taken up in a bath, in any amount, that could have the slightest effect.

The mother lye (*Mutterlauge*) is the thick yellow to reddish brown fluid which is left behind after boiling the sool water. It

forms a very concentrated (31 per cent. of solids) solution of chloride of calcium, chloride of magnesia, chloride of potass, chloride of sodium. We give as an example, the Kreuznach mother lye; it contains in 1 litre:

Chloride of sodium	. .	3·4
,, potass	. .	17·2
,, lithium	. .	14·5
,, calcium	. .	332·3
,, magnesia	.	32·4
,, strontium	.	2 8
Bromide of potass	. .	6·8

Other mother lyes are richer in chloride of sodium (Friedrichshall, Kösen, Ischl, &c.); others contain little chloride of calcium, but more chloride of magnesia (Kissingen, Salzungen, &c.)

The air of the graduating works, where the brine is concentrated by passing through walls of faggots of thorn, is damp and cool (the cold of evaporation), and contains, according to the movement of the air, more or fewer globules of the salt water, but in any case the amount is minimal. Good effects are promised in catarrhs of the respiratory organs from inhaling that air; but one would expect more gain in this way by using the inhalation rooms (baths of brine vapour), in which the brine is inhaled in a state of the finest division. Here, too, the chief curative agent is the vapour of water.

According to Vogel's experiments the air of the graduating works of Reichenhall contains, at a temperature of 59°, 75 per cent. of moisture and 1 to 3 milligrammes of salt in the litre of air. In the inhalation room, at a mean distance from the instrument which pulverises the brine, he found 80 to 86 per cent. of moisture, 6 to 8 milligrammes of salt in the litre of air.

I shall not enter further here into the various applications of brines in the forms of injections, fomentations, local baths, gurgles, &c.

For the preparation of artificial brine baths, their cheapness, as compared with the mother lye, recommends the half artificial salt known as 'cattle salt,' or the equally good 'Stassfurt potass salt,' to which Siegmund has lately called attention. It contains 16 per cent. of chloride of potass, 26 per cent. of chloride of magnesia, and 13 per cent. of common salt.

TABLE V.—SALT WATERS.

A. *Weak Salt Waters* (amount of chloride of sodium under 1·5 per cent.)

a. *Cold Wells.*

(Amount in 1,000 parts by weight of water; temperature according to Fahrenheit.)

Name of Well	Situation	Chloride of Sodium	Total of Solids	Free Carbonic Acid	Relatively Most Important Constituents—not Chloride of Sodium
Neuhaus,	Bavaria				
Bonifaciusquelle .	. . . . .	14·7	19·9	1,138	Chlor. calc., 1·2; sulph. mag., 1·4; carb. mag., 1·0
Elisabethenquelle	. . . . .	9·0	12·9	1,035	—
Sodenthal,	Near Aschaffenburg				
Soole . . .	. . . . .	14·5	2·1	—	Chlor. calc., 5·1
II. Quelle . .	. . . . .	5·2	8·4	—	" 2·4
Soden,	Nassau				
Soolbrunnen .	. . . . .	14·2	16·9	845	Temp., 69·2°
Champ.-Brunnen .	. . . . .	6·5	7·7	1,389	" 65·7°
Warmbrunnen .	. . . . .	3·4	4·7	1,015	" 73·4°
Kreuznach,	Nahe Valley				
Oranienquelle .	. . . . .	14·1	17·6	—	Brom. mag., 0·2; chlor. calc., 2·9
Elisenquelle .	. . . . .	9·4	11·7	—	Bromide mag., 0·04; chlor. calc., 1·7
Rehme, Bitterbrunnen	Weser Mountains	12·0	16·6	—	Sulph. calc., 3·2
Hall, Tassiloquelle .	Upper Austria .	12·1	13·0	120	Iod. mag., 0·04; bromide mag., 0·05
Kissingen,	Bavaria				
Schönbornsprudel	. . . . .	11·7	15·8	1,333	Sulph. mag., 1·4; temp., 68°
Soolsprudel . .	. . . . .	10·5	14·2	764	Temp., 64·4°
Rakoczy . .	. . . . .	5·8	8·5	1,305	Chlor. calc., 1·0
Also Sebes . .	Hungary . .	11·7	14·8	—	Sulph. soda, 1·0
Salzschlirf,	Fulda-Giessen				
Tempelbrunnen .	. . . . .	11·1	16·0	1,029	Chlor. mag., 1·3; chlor. lith., 0·1
Bonifac.-Brunnen	. . . . .	10·2	14·2	872	Chlor. lithium, 0·2
Königsdorff-Jastrz. .	Upper Silesia .	1·4	12·4	—	Iod. mag., 0·01; bromide mag., 0·02
Neu-Rakoczy . .	Near Halle, on the Saale	10·1 4·7	11·7 5·7	— —	— —

TABLE V.—SALT WATERS (*continued*).

Name of Well	Situation	Chloride of Sodium	Total of Solids	Free Carbonic Acid	Relatively Most Important Constituents—not Chloride of Sodium
Nauheim, Larsbrunnen	Wetterau . .	9·8	12·1	720	Chlor. calc., 1 0; temp., 65·7°
Salzhausen . .	Wetterau . .	9·4	11·7	—	—
Schmalkalden . .	Hesse. . .	9·3	14·0	—	Sulph., calc., 3·0
Dürkheim, Bleichbrunnen	Palatinate . .	9·2	11·8	146	Bromide soda, 0 01; chloride calcium, 1·9
Homburg, Elisabethbrunnen	Near Frankfort .	9·8	13·2	1,039	Chlor. calc., 1·5
Iwonicz . . .	Gallicia . .	8 3	10 6	351	Iod. soda, 0·01; bromide soda, 0·02; carbon soda, 1·7
Münster a. Stein .	Near Kreuznach	7·9	9·9	—	Bromide soda, 0·07; chlor. calc., 1·4
Wildegg . . .	Canton Aargau .	7·7	12·5	—	Iod. mag., 0 02; chlor. mag. 1·1; chlor. calc., 1·5; sulph. soda, 1 6
Pyrmont, Salzquelle	Waldeck . .	7·0	10·7	954	—
Mergentheim, Karlsquelle	Würtemberg .	6·6	13·9	297	Sulph. soda, 2·8; sulph. mag., 2·0
Heilbronn, Adelheidsquelle	Bavaria . .	4·9	6 0	409	Iod. soda, 0 02; bromide soda, 0·04
Arnstadt, Riedquelle	Thuringia . .	3·7	4·9	—	—
Sulzbad . . .	Lower Rhine .	3·2	4·3	—	—
Kronthal. . .	Nassau . .	3·3	4·5	1,258	—
Niederbronn . .	Alsace . .	3·0	4·6	—	—
Cannstadt . .	Near Stuttgart .	2·0	4·8	987	Temp., 64·4°-68°
Wiesbaden, Faulbrunnen	Nassau . .	3·4	4·3	—	Temp., 61·25°
Salzbrunn, Römerquelle	Bavaria . .	1·9	2·4	122	Iod. mag., 0·01
Krankenheil . .	Near Tölz, Bavaria	0·3	0·7	—	Iod. soda, 0·001; bicarb. soda, 0·3

TABLE V.—SALT WATERS (*continued*).

b. *Warm Springs.*

Name of Spring	Situation	Chloride of Sodium	Total contents	Temperature	Relatively most Important, Constituents—not Chloride of Sodium
Soden,	Nassau				
Soolsprudel .	. . . . .	14·5	16·8	87°	Bicarb. calc., 1·3; carb. acid, 756
Milchbrunnen .	. . . . .	2·4	3·3	76	Carb. acid, 951
Mondorf . .	Luxemburg .	8·7	14·3	77	Chlor. calc., 3·1; sulph. calc., 1·6
Wiesbaden,	Nassau				
Kochbrunnen .	. . . . .	6·8	8·2	154·4	Carb. acid, 200
Spiegelquelle .	. . . . .	6·8	8·1	150·8	" 248
Gemeindequelle	. . . . .	5·2	6·4	120·2	—
Bourbonne les Bains	Dept. Marne Sup.	5·8	7·6	136–180	—
Burtscheid . .	Close to Aix la Chapelle	2·8	4·1	140–165	Sulphate soda, 0·001
Baden-Baden,	Baden				
Hauptquelle .	"	2·1	2·8	154	—
Brühquelle .	"	2·2	3·0	154	—
Büttquelle .	"	1·8	2·7	111	Chlor. lith., 0·04
Battaglia . .	Near Padua .	1·6	2·3	136–160	—

B. *Stronger Salt Wells* (over 1·5 per cent. of chloride of sodium) *and Brines.*

a. *Cold Springs.*[1]

(Constituents in 1,000 parts water.)

Name of Well	Situation	Chloride Sodium	Name of Well	Situation	Chloride Sodium
Rheinfelden	Aargau . .	311	Salzdetfurth	Hanover .	57
Salzungen .	S.-Meiningen .	256–41	Elmen .	Near Magdeburg	48
Hall . .	Tyrol . .	255			
Jaxtfeld .	Würtemberg .	255	Kösen. .	Saal Valley .	43
Ischl . .	Salzkammergut	255–36	Colberg .	Pomerania .	43–33
Stotternheim	Near Erfurt .	250	Baassen .	Siebenbürgen .	40
			Castrocaro .	Tuscany . .	36
Frankenhausen	S.-Rüdolstadt.	248	Wittekind .	Near Halle on S.	35
			Salzuflen .	Near Herford .	33
Aussee .	Styria . .	244	Goczalkowitz	Upper Silesia .	33
Gmunden .	Salzkammergut	233	Pyrmont .	Waldeck .	32
Arnstadt .	Thuringia .	224	Königsborn, Badquelle	Westphalia .	26
Rosenheim .	S. Bavaria .	226			
Reichenhall	" .	224	Oldesloe .	Holstein. .	30
Traunstein .	" .	224	Artern .	Thuringia .	24
Aibling .	Upper Bavaria	224	Hall . .	Würtemberg .	23
Köstritz .	Reuss . .	220	Sudcrode .	In the Harz .	22
Bex . .	Cant. Waadt .	156	Orb . .	L. Franconia .	17
Sulza . .	Thuringia .	98–37	Hubertusbad	Hartz . .	15
Juliushall .	Brunswick .	66–61	Nauheim, Kurbrunnen	Taunus . .	15
Nenndorf .	Schaumburg .	53			
Rothenfelde	Near Osnabrück	53	Grossenlüder	Hesse . .	15

[1] Almost all of those springs contain (besides chloride of sodium) calcium and magnesium, and exceptionally chloride of potass; most are rich in sulphate of calcium. But all these salts are neither quantitatively nor qualitatively to be compared with the large amount of chloride of sodium. It seemed, therefore, unnecessary to give them in detail.

b. *Warm Springs (Thermal Brines).*

(Temperature above 77° ; amount of chloride of soda over 1·5 per cent.)

Name of Spring	Situation	Chloride Sodium	Carbonic Acid	Temperature
Rehme-Oeynhausen	Weser	85–24	753	87·8°–80·6
Nauheim, F. W. Sprudel	Wetterau . . .	29	578	95
Salzburg . . .	Hermannstadt, Hungary	157	—	86–71

6. SEA BATHS.

(See Table VI.)

V. Gräfe: 'Die Gasquellen Süditaliens u. Deutschl.' Berlin, 1842.—Lersch: 'Einleitung in d. Mineralquellenlehre,' 1853, vol. i.—Beneke: 'Ueb. d. Wirk. d. Nordseebades,' 1855.—Id.: 'Zum Verständniss d. Wirk. d. Seeluft u. d. Seebades.' Cassel, 1873.—Id.: On the same subject, *Deutsch. Arch. f. klin. Med.*, vols. xiii. and xx.—Id.: 'Ueber d. engl. Seebäder,' *Berlin. klin. Wochenschr.*, 1872, No. 25.—Wiedasch: 'Das Nordseebad.' Hanover, 1858.—Virchow: 'Physiol. Bemerk. über d. Seebaden u.s.w.,' *Virch. Arch.*, vol. xv. 1858.—Mess, in 'Valentiner's Handb. d. Balneotherap.,' 2nd edit. 1876, p. 480.—O. Jacobsen in 'Ber. d. Commiss. z. wissensch. Unters. d. deutsch. Meere i. Kiel, 1874–1876.' Berlin, 1878.—Fromm: 'Ueb. d. Bedeut. u. d. Gebr. d. Seebäder.' Norden, 1879.

The active factors in the use of sea baths are—1. The cold bath; the temperature during the bathing months varies in the German Ocean from 60·8° to 65·2°. The temperature of the Baltic is somewhat lower. 2. The salt contents of the water, which are for the German Ocean 28 to 30 grammes, for the Baltic 10 to 19 grammes in the litre. 3. The motion of the water, the force of the waves, which, as is well known, is far more energetic in the German Ocean, as in all seas having considerable ebb and flow, than in the Baltic, a few places with steep-descending shores excepted. 4. The important factor of sea air.

To this we must add the other factors of a bath cure, such as remaining and taking exercise in the open seaside air, the removal from household and business cares, altered diet, &c.

We have already given an account of the most important parts of the action of cold baths on the different organic functions, on the circulation, the respiration, the excretion of carbonic acid, the withdrawal and the production of heat. We

can pass over this portion of the subject the more shortly, as the operations of the cold bath have been already fully discussed in the chapter on hydrotherapy. A consideration of the physiological effects of the cold baths gives us many indications and contraindications for the use of sea baths.

The stimulus of cold to the cutaneous nerves produces directly, and by reflex action, a contraction of the cutaneous vessels. This is one of the most powerful means by which the system tries to protect itself against excessive cooling down. The diminution of the peripheral circulation, which accompanies the contraction of the vessels, causes the temperature of the periphery to sink rapidly, under the influence of baths that withdraw heat, while, at the same time, the temperature of the interior, where a lively generation of heat is taking place, is relatively protected from being cooled down by the diminution of the circulation occasioned by the cooling of the skin. As the peripheral contraction of the vessels causes a propulsion of blood towards the internal organs, cold and sea baths also are, as accords with the results of experience, contraindicated in persons who are inclined to internal hæmorrhages (hæmoptysis, hæmatemesis, apoplexy, uterine hæmorrhage, &c.)

It is possible that, as Ludwig assumed, the driving in of the blood, from the periphery to the internal organs, may cause a more active conversion of tissue in the interior (muscles, liver, &c.), by which the production of heat is a little increased. But it is quite certain, that this is not sufficient to cover the two- or threefold increase of heat production, which takes place when there is a strong withdrawal of heat. The maintenance of the interior temperature of the body, which even rises a little immediately after the impression of cold, as Liebermeister has shown by calculation and experiment, is effected by a production of heat proportionate to the loss of it. Along with this increase of heat production there goes hand-in-hand, as Liebermeister further shows, an increase of the excretion of carbonic acid, and also, according to Röhrig and Zuntz, an increased consumption of oxygen. The increase of the oxidation process is the livelier and the greater, within certain limits, the greater the loss of heat is, or, as others express it, the more intense the action of the stimulus of cold is on the cutaneous sensory

nerves, which last in sea baths is supported in its action by the stimulation of the salt contents, and of the blow of the wave. The stimulus of cold, otherwise the withdrawal of heat, produces reflexly an increase of the conversion of fat (Voit), while that of albumen, supposing the person to be well nourished and not lean, remains unchanged. As the balancing of the loss of heat in a cold bath makes increased demands on the combustion of fat, and the consumption of oxygen, it is intelligible how lean individuals, poor in blood corpuscles, show insufficiency in this respect, rather than well-nourished persons, rich in blood. This explains why very anæmic lean persons, convalescents from febrile complaints, cannot bear cold baths in general, or sea baths, and especially protracted ones. They cannot respond to the increased demand for the conversion of fat, required for the balancing of the temperature, or only do so at the expense of the albuminates; and when they cannot balance the heat sufficiently, they experience an injurious lowering of the temperature of the interior. Such persons feel very comfortable after using heated sea water baths, which are to be had in most seaside places. What we have said, of the contraindication of sea baths in anæmia, does not apply to that form of it, which has an increased supply of fat associated with it. Sea baths are useful, as in this, so also in the other form, when the anæmia depends on 'nervous relaxation,' 'irritable weakness,' or 'nervous dyspepsia.' Here sea baths often fulfil the causal indication, that is, remove the cause.

The sea baths enjoy an old and deserved reputation in scrofulosis, especially in that form which is usually called 'pasty,' in which the children look well nourished, and have a corresponding *panniculus adiposus.*

Sea bathing occasions a strong stimulation of the cutaneous nerves, by its cold, by its salt, and by the shock of the wave. There is no question that in this way, by a propagation of the stimulus to the central organ, certain actions are called forth in it, of which we do not, indeed, know the exact nature. If any kind of bath deserves the formerly so much abused name of 'nerve bath,' sea baths certainly do. Their good effects are recognised in so many affections that I shall only enumerate some of them; in hysteria, hypochondriasis, neurasthenia, 'irrit-

able weakness,' conditions produced by excesses of mental or of corporeal exertion, in 'nervous relaxation' and exhaustion, in nervous dyspepsia, in some neuralgias (migrains). Sea baths are 'amusement baths' κατ' ἐξοχήν.

Many assumptions respecting the operation of sea bathing, besides those which we have explained above, are current, but they do not inspire confidence in anyone who is acquainted with the requirements of strict analysis of the change of tissue processes. Thus, it has been said, that the urea and the sulphuric acid excretion are increased, while that of phosphoric acid and of uric acid is diminished. As far as I know, there are no exact experiments on the subject.

Cold baths, and especially sea baths with a maximum amount of salt and movement of the water, are recommended for hardening the skin of those who are subject to frequent relapses of rheumatism, of bronchial catarrh, and other diseases supposed to depend 'on catching cold.'

The factor of sea air is an important one in sea bath cures. Undoubtedly the purity of the air, its high amount of moisture (v. Gräfe), the increased pressure (at the level of the sea), and the free movement of the air, are valuable factors. Among them Beneke praises the force of the currents of air. The loss of heat of the body is increased by this, but the cutaneous transpiration is reduced by the moisture of the air, and the loss of heat is thus diminished. On the other hand, the high degree of moisture favours a little the loss of heat by radiation, while the greater density of the sea air acts as a better conductor of heat, and increases the loss of it. As the result of all these different influences, a mild, moderate, persistent, and what is specially boasted of, 'a very uniform excitement of the loss of heat,' is obtained; while on the other side, the increased current of air is supposed 'to facilitate the replacement of the heat which has been carried off at an increased rate' (see Beneke, *loc. cit.*) One can see from the foregoing specimens, how difficult, nay, how impossible it is, in the present state of our knowledge, to analyse scientifically, and in a satisfactory way, even one only of the climatic factors of sea air.

The uniformity of temperature on the sea shore, is said to make catching cold much less frequent there, than in the interior and among

mountains. On the other hand, it is declared that the stronger currents of air on the shore, act as a mechanical stimulant on the skin, and compress its vessels when they blow on its surface. After this stage of surface anæmia, a stage of hyperæmia is supposed to occur, when the wind remits. Hardening and other various effects are ascribed to this 'gymnastic of the cutaneous vessels'(!). The great moisture of the air of the strand, retards the giving off of water from the skin and from the lungs, and lessens the insensible perspiration; on this is supposed to depend the increase of the amount of urine, said to be caused by residence at the seaside. The consequence of the increased diuresis is, it is further assumed, an increase of the conversion of tissue (!). Physiological and therapeutical effects are ascribed further to the frequent and considerable variations of the barometer at the seaside. Some think that oxidation in the body is promoted, as there is a greater amount of oxygen taken in, owing to the higher pressure of the air. We know nowadays that the amount of oxygen that is taken in, does not determine the measure of combustion, that rather the demand of the organs for oxygen regulates the taking in and the expenditure of oxygen.

As respects the weight of the body during sea bathing, opinions are agreed that, in the majority of cases, an increase of it takes place during the course of the cure. It is obvious that such results of weighing are only of practical import, when taken in connection with other signs of improved nutrition, and that it is unnecessary to append other explanations and conclusions, such as the convenient one, that the appetite is increased by sea air.

With regard to the climato-therapeutic effect of staying by the seaside, consult the chapter in the climatotherapy of this work, which treats of it.

Temperature of the Sea Bath.

The temperature of water, suitable for sea baths, is reached at different periods of the year, in the different European seas. The southern ones, which are distinguished for the highest summer temperature, are the ones that reach the temperature for bathing earliest and keep it longest. Thus the bathing season in the Mediterranean extends from May into November. The mean summer temperature (June 21 to September 22) is

For the Mediterranean Sea	71·6°–80·6
,, Atlantic Ocean	68 –73·4
,, German Ocean	60·8–64·4
,, Baltic Sea	59 –62·6

Whilst the suitable temperature for bathing (from at least 64·4° to 66·2°) is usually reached in the Mediterranean in June, this is the case with the German Ocean in July, and with the Baltic in August. If the proper bathing temperature is once reached by the sea, it is maintained tolerably independently of the direction of winds and of the temperature of the air. Nevertheless the daily variations of the temperature of the sea water along the strand, are not so very slight and insignificant as has been usually assumed (compare Mess, loc. cit.) These differences are greater in seas where there is ebb and flow, than in the Baltic.

At most of the larger sea bathing places, artificially warmed sea water baths are supplied, which are especially suited for weakly constitutions, and are in all respects identical with warm brine baths in their action.

Amount of Salt in the Sea.

The chemical composition of sea water on the high seas, does not vary in any important degree in different seas and at different depths. This is true of its salts as well as of its gases. The experiments which O. Jacobsen made with specimens of water during the expedition of the 'Gazelle' in the years 1874 and 1876, showed a very uniform constitution of sea water. It is different with the amount of salt which it contains along various sea coasts. The salt amount along the shore, varies according to the amount of fresh water brought down by rivers. On this account, the amount of salt in the Baltic, especially east of Rügen (with the mouths of the Oder and Wesel), is, on the whole, distinctly smaller than in the German Ocean, the Atlantic, or the Mediterranean (see Table VI.)

The best known sea bathing places are—

A. German Ocean. *Heligoland*, Frisian Island, belonging to England, 9 hours from Hamburg—only for strong persons of good constitution; the ferrying over to the Dunes, where the bathing is carried on, of $\frac{1}{4}$ to $\frac{1}{2}$ an hour duration, is in stormy weather difficult, uncomfortable, and at times even dangerous; *Norderney*, province, Hanover, to be reached in $4\frac{1}{2}$ hours from Emden; *Ostend*, Belgian coast, elegant, comfortable, but noisy fashionable bath; *Scheveningen*, $\frac{1}{2}$ an hour from the Hague, expensive; *Blankenberghe*, Belgian coast, excellent bathing place, quite moderate prices; *Sylt* (Westerland), a Schleswig island, excellent, quiet, moderate bathing place; *Föhr* (Wyck), Schleswig island, south of Sylt, like it excellent, to be reached from Husum; *Borkum*, E. Frisian island, 3 hours from Emden, quiet sea baths; *Cuxhaven*, at the mouth of the Elbe, bathing place $\frac{1}{2}$ an hour distant from houses; *Zandvoort*, on the Dutch coast, near Haarlem and *Katwyck*, near Leyden, both excellent, quiet bathing places; *Dangast*, *Wangerooy*, on the Oldenburg coast, to be reached from Geestemunde,

also *Spierkerooj*, E. Frisian island. The last three simple but well-arranged places.

B. Baltic. The best known places are *Cranz*, near Königsberg; *Zoppot*, near Danzig; *Rügenwalde*, on the Pomeranian coast; *Colberg*, H. Pomerania; *Misdroy*, on the island Wollin; *Swinemünde*, also *Heringsdorf*, on the Island of Usedom; *Putbus*, Island of Rügen; *Warnemünde*, on Mecklenburg coast; *Doberan*, the same; *Travemünde*, near Lübeck; *Düsternbrook*, near Kiel; *Glücksburg*, in Flensburg harbour; *Apenrade*, N. Schleswig; *Marienlyst*, near Helsingör, on the Sound; *Klampenburg*, near Copenhagen.

C. The English Sea Baths. *Margate*, S.E. coast at mouth of Thames; *Ramsgate*, near it; *Hastings*, in Sussex; *St. Leonards*, united with last; *Eastbourne*, a few miles from the last; *Brighton*, south coast of England; the sea baths of the Isle of Wight: *Ryde*, *Cowes*, *Sandown*, *Shanklin*, *Ventnor*. [The French sea bathing places on the opposite coast would naturally have been mentioned here, as well as the very numerous ones on the eastern and western coasts of England and of other parts of Great Britain.—*Tr.*]

D. Sea Baths of the French Coast and the Mediterranean. *Biarritz*, in Bay of Biscay; *Marseilles*, *Nice*, *Naples*, *Leghorn*, *Messina*, *Trieste*, *Venice* (bathing at the Lido). The bathing season extends, in those last-mentioned places, from May till into November. However, the months from July to September, on account of the oppressive atmosphere and the high temperature of the sea, are not suited for bathing, as baths at that season do not produce the feeling of refreshment and of bracing, which belongs to sea baths in the German Ocean and Baltic at that period of the year.

Table VI.—Sea Waters.

(Grammes in one litre of water.)

—	Situation	Chloride Natrium	Chloride Magnesium	Sulphate Magnesium	Sulphate Calcium	Total
Atlantic Ocean	Near Havre	24·7	2·7	—	1·1	30–37
German Ocean	Ostend	22·4	5·2	4·4	0·7	28–30
,,	Scheveningen	24·5	3·8	1·2	0·5	
,,	Heligoland	20·6	3·3	2·7	1·0	
,,	Norderney	21·7	8·2	—	0·1	
Baltic Sea	Travemünde	8·8	2·8	—	0·6	10–19
,,	Doberan	10·9	4·6	—	0·5	
,,	Putbus	9·0	2·9	—	0·4	
Mediterranean and Adriatic Seas	Venice	21·3	3·0	2·3	0·5	32–41
,,	Leghorn	32·8	4·7	2·7	1·0	
,,	Nice	30·0	3·0	4·2	3·7	
,,	Marseilles	48·5	10·0	7·8	0·7	

7. THE IRON WELLS.

(See Table VII.)

Prokrowsky: *Virch. Arch.*, vol. xxii. 1861.—Dietl and Heidler: 'Ueb. d. Resorpt. von Eisenverb.,' *Prag. Vierteljahrschr.*, 1874, vol. ii. p. 89.—Dietl: 'Exper. Stud. über d. Ausscheid. d. Eisens,' *Sitz.-Ber. d. k. k. Akad. d. Wissensch.*, 1875, vol. li.—Th. Valentiner: 'Bad Pyrmont 1858,' and in his 'Handb. d. Balneotherap.,' 1876, 2nd edit.—Buchheim: 'Lehrb. d. Arzneimittellehre,' 3rd edit. 1878, p. 213.—Quincke: 'Ueb. d. Verh. d. Eisensalze im Thierkörper,' Berlin, 1868, and *Arch. f. Anat.*, 1868.—Schroff: 'Lehrb. d. Pharmakol.' Vienna, 1826.—L. Scherpf: 'D. Zust. u. Wirk. d. Eisens.' Würzburg, 1877.—Woronichin: *Jahrbuch d. Ges. d. A. in Wien*, 1868.—Hamburger: 'Ueb. d. Aufn. u. Ausscheid. d. Eisens,' *Zeitschr. f. physiol. Chemie*, vol. ii. 1878, vol. iv. 1880.

The quantity of the bicarbonate, rarely of the sulphate of oxide of iron, found in this class of wells, is, on the whole, exceedingly small, and varies between 0·03 and 0·1 of a gramme of bicarbonate of iron in the litre of water. If, in the preceding pages, we have classed among the alkaline, the Glauber salt, and chloride of sodium waters, and many springs which contained a little iron (sometimes, indeed, more than is contained in the regular 'Iron Wells'), this was done, only on the principle that the name was given from the most important constituent.

In mineral waters bearing the title of 'iron or steel waters,' the iron plays relatively a greater part, the poorer the spring is in its other contents. The total amount of solid contents varies between 0·4 and 6 grammes in the litre, and is in most of them under 3 grammes. All the wells of this class, excepting those which contain sulphate of iron, are iron acidulous ones, i.e. distinguished by the presence of a greater or less amount of carbonic acid. Some of them contain a not insignificant amount of bicarbonate of soda (the maximum 1·2 gramme in the litre), and are therefore called 'iron acidulous springs;' others contain Glauber salt (the maximum 3·5 grammes to the litre), and are called 'iron saline waters,' while others contain common salt (the maximum 2 grammes to the litre), and are called 'muriatic acidulous iron springs;' finally, some contain a certain amount of carbonate or of sulphate of lime (maximum of 2 grammes in the litre). These are called 'earthy acidulous iron waters.'

All iron springs are cold, with the exception of a few lying far from Germany (Rennes, Schelesnowodsk, Sylvanès, and some others).

The temperature required for baths is obtained by introducing steam either directly into the water, or between the walls of a bath with a double bottom, or into tubes that pass through the water.

Iron was the panacea for poverty of blood, long before the discovery of hæmoglobin, which contains iron. The later view, that iron exhibited internally, in oligochromæmia and oligocythæmia (deficiency of colour, deficiency of cells), induced both an increase of the hæmoglobin in the blood corpuscles, already present, as well as an increase of their number, agreed so well with the manifold good effects of this agent in the treatment of chlorosis and of anæmia, that for a long time, no doubt could be entertained of the correctness of the theory. But the view, that in cases, where chlorosis or anæmia improve under the use of iron, that substance is really the curative agent, which promotes the formation of blood, does not stand the test of close criticism. The dietetic rules, which are usually united with an iron cure, are of themselves often sufficient to cause the improvement and cure of anæmia. How often, in cases of chlorosis, especially in the serving classes, is a stay of a week or a fortnight in a hospital, with rest and good nourishment, sufficient, without any medication, to improve the appearance of the patient, to increase the quantity of her blood corpuscles considerably, and to relieve her troubles ; and, on the other hand, how often do we see the chlorosis of development, run on and increase, in spite of the exhibition of iron in large or small doses. The chlorosis goes on increasing, although a sufficient amount of iron may be daily introduced in the nourishment, but which passes away again unused in the excretions. If the blood's craving for iron were the cause of chlorosis, the retaining of a small amount of the iron, which is supplied in the daily nourishment, would suffice to cover the deficit in the blood. We find that chlorosis arises from other causes, than an impoverishment of the blood in iron, and therefore a plus of iron supplied medicinally will not cure it. It is another question, whether, in a certain stage of chlorosis, if the conditions of recovery, which are unknown to us, have begun to set in, the administration of iron in increased quantity, may not facilitate and quicken the regeneration of blood, and the formation of new blood corpuscles. If we answer

this question in the affirmative, another one arises, whether the quantities of iron, contained in mineral waters, are sufficiently large, to enter into comparison with the amount of iron, that is supplied in the food. The quantity of iron taken in daily in the food, amounts, according to Boussingault, to about 0·08 to 0·09 of a gramme. Fleitmann found the amount given off daily in the urine and fæces, to be similar. If we assume, that 1 litre (4 to 5 glasses) of the strong Schwalbach Stahlbrunnen is drunk daily, the amount of the bicarbonate of iron taken in, will be 0·08 of a gramme, or 0·04 of simple iron. It must be admitted, that, under normal conditions, an excess of iron taken in, is accompanied with a corresponding increase of iron, passed in the urine and fæces, so that almost the whole excess of iron seems to reappear in them. This is the case under normal circumstances, but that does not exclude the possibility, that in pathological ones, the iron may be retained and used for building up the blood. From this point of view, even the small quantities of iron, that are taken in during an iron water cure, may be of some significance. Even when the blood-making process is going on rapidly (and my observations on the amount of hæmoglobin in chlorosis, would indicate a frequently very quick restoration of the blood), perhaps only very small quantities of iron are required, for the regenerative process. This seems the more possible, when we recollect, that the whole amount of iron in the blood of an adult, amounts to about 3 grammes only.

Nevertheless, there is no real ground to attribute to the iron of the wells, the good effects in chlorosis and anæmia, which are observed from drinking and bathing at steel wells. The different powerful factors of bath life, the altered diet, and mode of life, the living in the open air and the mountains, the removal from domestic cares, the use of baths rich in carbonic acid, the increase of appetite, all contribute to the fortunate result; if they are not the only factors, they are certainly far more important, than the 4 to 8 centigrammes of bicarbonate of iron, which are swallowed in the waters in twenty-four hours. It agrees with this view, that the cure of chlorosis and of anæmia, is professed at almost all baths, and that, as a matter of fact, they are relieved by the most different drinking cures, as well

as by cures in the mountains, or at the sea shore. These undeniable facts, make it impossible, to join in the wide-spread belief, of a specific operation of iron waters in chlorosis and anæmia.

The bicarbonate of iron, which has reached the stomach, undergoes there various decompositions, by the free acids of the stomach, by the albuminates, and by the phosphates, about which there is still difference of opinion (compare Buchheim, 'Arzneimittellehre,' p. 216 ff.) The suboxide of iron salts are quickly converted, in the stomach, chiefly into oxide salts (Mitscherlich, Bernard, Mayer, and Buchheim); at all events this change takes place in the upper part of the intestinal canal, where the reaction is alkaline from the bile and the pancreatic juice. Most likely the whole iron is absorbed, as a compound of iron and albuminates. Since nearly as much iron is found in the fæces (as black sulphide of iron), as has been supplied medicinally to the body, many have thought, there were grounds for considering, that only very little iron was absorbed. But this conclusion is incorrect. Even when iron is introduced into the body in other ways, as by injection into the veins, the greater portion of it is found again in the fæces (A. Mayer). The intestinal canal therefore appears to be an important place for the excretion of the superfluous amount of iron, which has been taken into the blood, and which probably returns to the bowel, through the medium of the bile or the pancreatic juices, possibly through the fluids of the intestinal canal.

Meantime the experiments of Quincke are opposed to these conclusions of A. Mayer. He injected various salts of iron into the blood of dogs, or added lactate of iron to their food, and after that examined for iron, the secretion of these animals, procured through Thiry's intestine fistulas, without finding any increased quantity of it in the fresh secretion. E. W. Hamburger has very lately made experiments in dogs, on the excretion by the bile of iron salts, that have been supplied to them. He arrived at the conclusion, that the bile takes no part in the excretion of the iron that has been introduced. As then none of the other intestinal secretions carry away any considerable amount of iron, Hamburger concludes, and certainly rightly, that the absorption of iron from the intestinal canal is very slight, and confined within very narrow limits. If Hamburger added sulphate of iron to the meat given to dogs, the greater part of the iron given with the food appeared in the fæces again, while the amount of iron in the urine was scarcely increased at all. For instance, of the 441 milligrammes of iron given, as salts of iron, in the first series of experiments, only 12 milligrammes

appeared in the urine, while 413·4 milligrammes reappeared in the fæces, showing a loss of 15·6 milligrammes of iron.

We cannot doubt what Dietl and Heidler say about the absorption of iron salts in the stomach.

The question, whether the amount of iron in the urine is increased, by the exhibition of that substance, still remains undecided. The small *plus* which is observed in urine, after the exhibition of iron, does not exceed the limits of mistakes in analysis, or the normal variations that may be the result of the different amounts of iron that may be present in the food. Kölliker, Müller, and Quincke saw iron appear in the urine, immediately after the exhibition of citrate or tartrate of iron; other observers could not satisfy themselves of any increase of iron in the urine, under similar circumstances. Schroff obtained the wonderful result, that the absorption and passage of the iron into the urine increases in proportion to the smallness of the amount administered. Braune considers this to be a 'most important and instructive fact.'

There are a few accounts of the influence of iron on the conversion of tissue. Rabuteau and Valentiner observed an increase of the excretion of urea. But these experiments rest on such imperfect methods (neglect of equipoise of nitrogenous amount), that belief can scarcely be accorded to them. The same remark applies to the so often quoted conclusion of Prokrowsky, that the use of iron raises the temperature of the body, increases the pulse frequency and the blood pressure.

The amount of carbonic acid present in iron springs, is, apart from the water, a great element of the drinking cures with iron waters. It has ascribed to it a favourable influence on anæmic dyspepsia, on chronic stomach and bowel catarrhs, and it is believed that the gas favours the absorption of the iron. In a similar way, according to Woronichin's experiments on dogs, the absorption of iron is assisted by the addition of salt, a result which should be found useful by the muriatic steel wells. Many chlorotic patients do not bear cold carbonated drinks well; on this account they are often warmed, or have warm additions made to them. With reference to the action of carbonic acid, I refer to what was said under the head of Acidulous Springs.

The growing cloudy, or rusty, of exported iron waters, depends on the oxidation of the carbonate of the suboxide of iron, into the insoluble hydrated oxide of iron. Struve's 'pyrophosphoric iron water'

makes the despatch of natural mineral waters unnecessary, in more than one point of view.

In the use of iron waters as baths (excepting water and its temperature), the rich supply of carbonic acid, is the only agent of any importance, as a stimulant to the skin: possibly the unimportant amount of salts present, may contribute faintly in that way. The iron itself is balneologically of no importance whatever. Even bath specialists no longer believe in the absorption of iron through the skin. All, therefore, that we have already said about carbonic acid baths, applies to iron ones rich in that gas. [Most writers on balneology would have here entered, at some length, on the treatment of the several affections of women by the use of iron waters.—*Tr.*]

TABLE VII.—IRON WATERS.[1]

(Parts in 1,000 parts of water by weight. The carbonates as bicarbonates free of water.)

Name of Well	Situation	Bicarbonate of Iron	Cub. Cm. Carbonic Acid	Relatively most Important Salts
Muskau,	Oberlausitz			
Badequelle .	. . . . .	0·51	—	Sulph. iron, 0·74
Trinkquelle .	. . . . .	0·24	—	" 0·2
Elöpatak . .	Siebenbürgen .	0·29	1,254	Bicarb. soda, 1·2; bicarb. calc. mag., 1·8
Szliacs . . .	Hungary . .	0·12	1,385	—
Rippoldsau, Wenzelquelle	Black Forest . .	0·12	1,040	Bicarb. calc. mag., 1·5; sulph. soda, 1·0
Königswart . .	Bohemia . .	0·11	1,163	—
Pyrawarth . .	Lower Austria .	0·11	428	—
Freiersbach . .	Black Forest . .	0·10	971	—
Homburg, Stahlbrunnen	Near Frankfort .	0·1C	1,082	Chlor. sodium, 5·8
Sangerberg . .	Bohemia . .	0·10	1,014	—
Polzin . . .	Pomerania . .	0·09	—	—
Lobenstein . .	Reuss . . .	0 08	33	—
Elster . . .	Saxony . . .	0·08	1,310	Chlor. sodium, 1 4; sulph. soda, 2·0
Liebenstein . .	Thuringia . .	0·08	1,003	—
Schwalbach . .	Taunus . . .	0·08	1,570	—

[1] 0·03 of bicarbonate of iron is the smallest amount in its waters of the springs admitted into this table.

TABLE VII.—IRON WATERS (*continued*).

Name of Well	Situation	Bicarbonate of Iron	Cub. Cm. Carbonic Acid	Relatively most Important Salts
Bocklet . .	Near Kissingen .	0·08	1,505	Chlor. sodium, 0·8
La Malou . .	Hérault, France .	0·08	—	—
St. Pardoux . .	Allier „ .	0·08	—	—
P. de Neyrac .	Ardèche „ .	0·08	—	—
Reiboldsgrün .	Saxony . . .	0·07	—	—
Driburg . .	Westphalia . .	0·07	1,165	Bicarb. calc. mag., 2·1
Griesbach . .	Black Forest . .	0 07	1,266	Bicarb. calc. mag., 1·6; sulph. soda, 0·7
Franzensbad,	Bohemia			
Stahlquelle .	. . . . .	0·07	1,528	Sulph. soda, 1·6
Kalter Sprudel .	. . . . .	0·03	1,576	Sulph. soda, 3·5; chloride soda, 1·1
Pyrmont . .	Waldeck . .	0·07	1,271	Bicarb. calc. mag., 1·1
Malmedy . .	Rhine Provinces .	0·06	1,080	—
Steben . . .	Upper Franconia .	0·06	1,203	—
Spaa . . .	Belgium . .	0·06	304	—
Ronneburg . .	Sachs-Altenburg .	0·06	127	—
Reinertz . .	Silesia . . .	0·05	1,097	Bicarb. calc. mag., 1·5
Imnau . . .	Würtemberg . .	0·05	987	Bicarb. calc. mag., 1·6
Niederlangenau .	Glatz . . .	0·05	1,212	Bicarb. calc. mag., 1·1
Berka . . .	Near Weimar .	0·05	—	Sulph. calc., 1·6
Godesberg . .	Near Bonn . .	0·05	1,399	Bicarb. soda, 1·3; chlor. sodium, 0·9
Charbonnières .	France . . .	0·04	—	—
Alexisbad . .	Hartz . . .	0·04	294	—
Antogast . .	Black Forest .	0·04	947	—
Petersthal . .	„	0·04	1,366	Bicarb. calc. mag., 2·0
Gonten . .	C. Appenzell . .	0·04	—	—
Althaide . .	Glatz . . .	0·03	—	—
St. Moritz . .	Upper Engadine .	0·03	1,282	Bicarb. calc. mag., 1·5
Soultzbach . .	Alsace . . .	0·03	—	—
Sternberg . .	Bohemia . .	0·03	304	—
Liebwerda . .	„	0·03	780	—
Flinsberg . .	Silesia . . .	0·03	1,333	—
Tarasp, Wyquelle	Lower Engadine	0·03	1,585	Bicarb. calc. mag., 2·0
Cudowa . .	Silesia . . .	0·03	1,213	Bicarb. calc. mag., 0·9; bicarb. soda, 1·2
Krynica . .	Gallicia . .	0·03	1,286	Bicarb. calc., 1·4
Ronneby . .	Sweden . .	—	—	Sulph. iron, 2·4; sulph. alum, 1·5

Artificial Iron Waters.

Struve's pyrophosphoric iron water	Contains in 1 litre 0·10 metallic iron = 0·29 bicarbonate of iron	3 volumes of carbonic acid in 1 volume of water
Ewich's pyrophosphoric iron water	Contains in 1 litre 0·14 metallic iron = 0·4 bicarbonate of iron	
Ewich's effervescing iron water	Contains in 1 litre 0·1 bicarbonate of iron	

8. SULPHUR WELLS.

(See Table VIII.)

Amelung and Falk: *Deutsch. Klin.*, 1864 and 1865.—Eulenberg: 'D. Lehre v. d. schädl. u. gift. Gasen.' Brunswick, 1865.—Kaufmann and Rosenthal: *Arch. f. Anat. u. Physiol.*, 1865.—Hoppe-Seyler: 'Medic. chem. Unters.,' Tüb., i. 1866.—Diakonow: Ibid. ii. 1867.—Husemann: 'Suppl.-Bd. z. Toxikolog.' Berl. 1867.—Lersch: 'Fundam. d. Baln.' Bonn, 1868.—Schuster: *Deutsch. Klin.*, 1864, Nos. 22–25.—Id.: 'Ueb. d. Verh. Körperwärme,' *Virch. Arch.*, vol. xliii.—Buchheim: 'Arzneimittellehre,' 1878, 3rd edit. p. 95.—Böhm: 'Intox. mit H_2S,' in *V. Ziemssen's Handb. d. spec. Path. u. Therap.*, vol. xv.—Röhrig: 'Physiol. d. Haut,' Berl. 1876, pp. 31 ff. and 184.—Liebreich: 'Verh. d. balneol. Sect. z. Berl. 26 Jan. 1879,' p. 38.—Reumont, in 'Valentiner's Handb. d. Balneotherapie,' 1876, 2nd edit. p. 291 ff.—Husemann: 'Die Balneotherap. d. chron. Metallvergift.,' *Oesterr. Badezeit.*, 1879, No. 12.—Güntz: 'Ausscheid. d. Quecksilb. nach dem Gebr. d. Aachener Kaiserquelle,' *Vierteljahresschrift f. Dermatolog. u. Syph.*, 4th year, 1877, p. 297.—Id: 'Das Vermög. der Schwefelwässer bei latent. Syphilis d. Sympt. derselben wieder z. Erscheinung z. bring.' Dresd. 1877.—Id.: 'Hg-Ausscheid. b. Anwend. v. Salzbädern,' *Wien. med. Presse*, 1877, Nos. 45–48.—Id.: 'Neue Erfahr. üb. d. Behandl. d. Quecksilberkrankh. mit Berücksicht. d. Schwefelwässer u. Soolbäder.' Dresd. 1878.—O. Ziemssen: 'Zur Ther. d. const. Syph.' Leipz. 1879.—Reumont: 'D. Behandl. d. const. Syph.' Aachen, 1878.

The group of sulphur wells, embraces mineral waters, which are provided with a really wonderfully small amount of hydrosulphuric acid (H_2S) or of sulphides (sulphide of sodium, calcium, magnesium, potassium), or of both together.

These wells have chiefly to thank their sulphurous smell for having been easily recognised, in pegology, as sulphur waters. In those days, when sulphur was a remedy in great repute, as an expectorant (*balsamum pectoris*), a diaphoretic, as acting on the portal system, as an alterative and a laxative, all kinds of wonderful effects were expected from the action of the natural

sulphur waters. Since the science of nature's medicine, throwing off the ballast with which it was weighted, has been based on physiological experiment and on clinical observation, the employment of sulphur as medicine is confined to a few indications. The faith in the mysterious powers of these waters, has been further shaken, by the positive results of chemistry, which prove the minimal amount of sulphur present in them.

The amount of hydrosulphuric acid, absorbed in water or rising from it, is extremely small, varying between a mere trace and 42 cubic centimetres (Herculesbad) in the litre. Many of the sources, usually reckoned among sulphur ones—for instance, the famous Pyrenean ones—are devoid of hydrosulphuric acid, and owe their titles to a minimal amount of sulphide of soda (0·07 the maximum at Luchon). As they are also very poor in other constituents, they would much more properly be classed as indifferent thermals, and this remark applies to many of the sulphur thermals of Germany, Austria, Hungary, and Switzerland.

Sulphur wells, in general, are poor in solid constituents. Among the richest are Herculesbad, with 7 grammes, and Aix la Chapelle (Burtscheid), with 4 grammes of solids in the litre of water. Some of these baths take the name of sulphur salt baths, on account of containing a small amount of chloride of sodium. Those which have the best cause to name themselves thus, are Herculesbad, with 3·8, and Aix la Chapelle, with 2·6 grammes of chloride of sodium in the litre. But, to see how freely such titles are dealt with, we have only to observe, that Reumont classes Baden, in Switzerland, and Weilbach among these baths, because they contain 0·3 and 0·27 gramme of salt respectively in the litre. A few sulphur wells are called alkaline, on the ground of containing small amounts of alkalies. How easily such titles are won is shown by the fact, that the strongest German alkaline sulphur waters, Aix la Chapelle and Grosswardein, do not contain more than 0·6 and 0·8 respectively of carbonate of soda in the litre of their waters. Some wells boast of their large amount of chloride of lime (Herculesbad, with 2·7, Baden, in Switzerland, with 1·3 gramme in the litre), and even of their gypsum, of which most springs are not proud. Thus Nenndorf and Schinznach, with 1, Eilsen, with 1·7, Gurnigel, with 1·3, Meinberg, with 0·8 gramme of sulphate of lime in the litre of their waters, are called 'earthy or sulphate of lime sulphur waters.' Baden, in Switzerland, may be counted a saline well, with 1·8 gramme of sulphate of soda. We have thus muriatic, alkaline, earthy saline, and still more grandly named sulphur waters, formed

by putting together two or three of these epithets. With few exceptions the chemical titles represent no therapeutic action.

When we consider their small amount of sulphur (which makes the physiological or therapeutical effects of these waters, to say the least, doubtful). and also their usually small amount of salts, it is plain, that this class of waters would more appropriately be joined to the indifferent or weak alkaline, or weak salt thermals, or the earthy wells, and some of them, as Langenbrücken and Meinberg, to indifferent waters, not forgetting, however, that the excellent opportunities for bathing and drinking at the two last-named places, are all the same worthy of balneological consideration.

Most of the sulphur waters contain small quantities of nitrogenous organic substances, which have been called glairine, baregine, and sulphuraire. The times, in which these impurities of the waters were regarded as having special effects, have scarcely yet gone by, and they are still praised in modern books on balneology.

Than discovered, in the year 1867, carbonic oxysulphide in a Hungarian well, a body which can be procured in the laboratory from sulphur, cyanide of potass, and sulphuric acid, and which may be regarded as a carbonic acid, from which one atom of oxygen has been taken by the sulphur, or as COS. This body is very easily decomposed. It forms with the presence of water, by conversion, hydrosulphuric acid and carbonic acid; thus this substance might be one of the sources of generation of hydrosulphuric acid in wells. Liebreich thinks that COS, taken as such into the blood, is there decomposed into hydrosulphuric and carbonic acids, and that this hydrosulphuric acid, in its nascent state, produces a more powerful effect on the blood, than when it is taken in by the mouth or by inspiration. The question, how much COS is eventually contained in the litre, how much is absorbed, how much of it is changed into hydrosulphuric acid in the stomach, these, and many other questions, still remain open ones. It is more than probable (I speak here without reference to the chemical interest it possesses), that this new substance, which has been greeted so emphatically by balneotherapists, may have no real physiological or therapeutic importance in sulphur waters.

What actions, then, can be ascribed to the hydrosulphuric acid and to the sulphides contained in sulphur wells? Can we build therapeutic indications on them, or explain their empirically proved effects?

As regards the fortune of hydrosulphuric acid, which has reached the stomach, or has been developed there from the

sulphides, a part of it is expelled by eructation. There is no obstacle in the way of the absorption of hydrosulphuric acid by the blood. The gas diffuses itself easily from the mucous surface of the digestive tract into the blood, and the absorption of the gas contained in the water is equally easy.

It is known, that hydrosulphuric acid is one of the most poisonous of the gases. The deleterious effects of this gas on the blood, have been thoroughly studied by Hoppe-Seyler, Diakonow, Preyer, and others, in their remarkable experiments. The hydrosulphuric acid causes the decomposition of the hæmoglobin, with the formation of a compound of sulphur and hæmoglobin, which is recognisable by spectral analysis. The inorganic salts of the blood plasma are, according to Diakonow, converted into sulphur alkalies, which become oxidised into sulphur and sulphuric acid salts, at the cost of the oxygen of the hæmoglobin.

According to Rosenthal and Kauffmann, a rapid oxidation of the hydrosulphuric acid takes place, by which oxygen is taken from the blood in such quantity, that, in combination with the other actions in the central nervous system, it produces death by asphyxia. The experiments of the two last-named investigators, have led to the result, confirmed by later observers, that hydrosulphuric acid has a directly injurious effect on the movements of the heart of mammals. The phenomena consist in a primary retardation of the pulse, and diminution of the blood pressure (dependent on central stimulation of the vagus), and in the gradual remission of the heart's activity, till there is a diastolic stillstand.

These and some other experiments, which are of extraordinary interest, for explaining the phenomena of hydrosulphuric acid poisoning, have been eagerly made use of, for explaining the physiological effects of sulphur waters. The conclusion drawn from this has been : because hydrosulphuric acid, taken into the blood in large quantities, exercises such a deleterious influence on it, and on the various organs, therefore the minimal quantities of the gas, which are taken in in drinking sulphur waters, produce qualitatively similar, though not so deleterious, effects on the system. Reumont believes, that 'the symptoms affecting the vascular and nervous systems in poisoned animals, show,

in their early stage, many analogies with the medicinal effects of various sulphur waters.'

It is obvious, that we cannot here think of transferring to the domain of balneology, those interesting physiological studies on the mode of blood decomposition, in poisoning by hydrosulphuric acid. The minimal quantities of that gas, which eventually reach the blood, after drinking even unusually large quantities of the Aix la Chapelle or of still stronger sulphur waters, are immediately eliminated again by the lungs—traces of it possibly by the skin—and if we suppose, that they undergo combustion in the lungs, yet the quantity of oxygen consumed thereby is so small, that it cannot stand any comparison with the oxygen storage of the blood, while such small loss as may be sustained, is restored by every inspiration. Granted that a few red corpuscles may be destroyed by the hydrosulphuric acid, or that a few plasma salts are converted into sulphates, yet no perceptible influence on the composition of the blood can be expected from these influences, because even in drinking sulphur waters, or in inhaling the sulphur gas, that surrounds them, only minimal quantities of the gas reach the blood, and are in great part eliminated again through the lungs.

Some have been able to see a stimulating effect of hydrosulphuric acid on the vagus centre, because, as Grandidier, Zögel, Verdat, and other bath physicians give out, a retardation of the movements of the heart, amounting to a few beats in the minute, is said to occur after inhaling the gas in a bath, and also after the internal use of these waters. It is more difficult to reply to this, than many would suppose (quite apart from the direction in which the supposed result would point); and for this reason, that along with the swallowing of the water, various other influences (bathing, water drinking, &c.) come into play, which may alter the pulse, which indeed varies, under normal circumstances, much in the same way as that attributed to the hydrosulphuric acid. If investigations on this subject are to give any useful results, they must be conducted in a mode quite different from what has hitherto been adopted.

Along with the pulse-retarding action of sulphur water, which is attributed to stimulation of the vagus, the 'sedative character,' the 'quieting influence on the nervous system' are

proclaimed. These effects, according to Reumont, are to be referred chiefly to the operation of the gas inhaled in the bath; and in the same breath, when this quieting action, 'the pleasurable feeling,' and the 'pleasurable relaxation' are perceived, the irritating action of the gas on the cutaneous nerves is brought forward, which, according to Reumont, shows itself in 'lively pricking and burning,' and therefore in very unpleasurable feelings: the gas of the sulphur waters is said to have a 'powerful action on the nervous system, as the experiments on animals show;' they were, in fact, made with large doses, which caused poisoning and death. From this are derived the indications for the use of sulphur baths in various neuroses, also in 'lowering the morbidly increased irritability of the nerves.' Although we do not feel justified in attributing any, even the most minimal, effects to sulphur, at the same time we cannot doubt, that the warm baths, along with the other factors of bath life, are often advantageous in various chronic diseases of the nervous system.

Different, some purely conjectural, therapeutic theories have been based on certain physiological experiments on the action of hydrosulphuric acid on the blood. I shall mention some of them here. The critical sense of my readers will readily dispose of them.

First, the famous 'blood-moulting theory' of sulphur waters. The hydrosulphuric. acid carried over into the stream of the *vena portæ* developes here, at once, 'the primary action of the gas' (Reumont), while it destroys the 'old melanotic (!) blood corpuscles' and forms sulphide of iron with them. In this way the destruction of the red corpuscles is effected,[1] the blood is purified, &c. But ample material for the formation of bile is also thus supplied, and the liver is stimulated to greater activity. On this theory is grounded the common recommendation of sulphur water in certain diseases of the blood and liver, in 'general plethora,' 'chronic enlargement of the liver,' 'obstruction of the portal system,' 'abdominal plethora,' &c.

The cholagogic action of sulphur, is much spoken of, although there is no proof, that it possesses any such power. It appears to

[1] Reumont even thinks that a destructive influence of the gas on healthy corpuscles can be recognised in many phenomena, which occur during the excessive use of sul hur waters.

be sufficient for many, for the explanation of the fact, to know, that the liver is 'the organ richest in sulphur,' and that it secretes taurin, which contains sulphur, from which it naturally follows, that 'an important part of the conversion of sulphur takes place in the liver' (Bidder and Schmidt).

The sulphur waters enjoy a great reputation in the treatment of chronic metallic (mercury or lead) poisoning. The hydrosulphuric acid or the sulphides, taken up into the fluids of the system, make the injurious metallic albuminates innocuous, either by converting the lead into insoluble sulphide, which, owing to the alkalescence of the fluids, may remain in the cells, as harmless as a small shot in its cyst, or by converting the mercury into sulphide of mercury, which is dissolved by sulphide of potass, owing to the presence of carbonated alkalies, and is thus easily eliminated by the urine.

As regards the treatment of acute and subacute metallic intoxication, the springs containing the sulphates of soda and of magnesia, are undoubtedly to be preferred to all others. They are able to convert the lead, found in the digestive canal, into insoluble sulphides, and they also by their purgative action favour its removal from the body. These waters are also of importance in chronic lead poisoning. If the excretion of lead is favoured, and especially, as has been assumed, its removal through the bile is stimulated by copious water drinking, by baths, by exposure to the open air, Glauber salt and Epsom salt waters may also act favourably, by expelling the increased amount of lead, which has been excreted into the digestive canal. If drinking and bathing cures, with sulphur waters, are beneficial in chronic lead poisoning, this is mainly owing to increased consumption of water, and to the increased movement throughout the tissues excited by it, possibly also to an increased decomposition of albumen, including the albuminates of lead. These effects of drinking cures, may be supported essentially by baths, especially hot baths, by vapour baths, and by increased exercise in the open air. But there is no specific action of sulphur in such cases. The same good effects follow, and for the same reason, drinking and bathing cures with indifferent waters, or with others containing salt, sulphate of soda, or other substances.

The assumption of a specific action of sulphur waters in chronic mercurialism, stands on an equally weak foundation.

Astrié thought, that the sulphur alkalies of these waters assist the removal of mercury, by making the metallic albuminates soluble, and the more so, because the different secretions, and especially that of bile, are promoted by the simultaneous use of baths and water drinking. The sulphate salts, which are formed out of them in the blood, are supposed to act like the sulphur alkalies. Güntz has very lately made a series of observations, on the excretion of mercury during the use of sulphur waters. He was able to detect mercury, in the urine of patients, during the use of the Aix la Chapelle mineral waters (who before had gone through a mercurial inunction cure), and this, although no mercury could be detected shortly before the sulphur water was taken. Güntz explains this action of the sulphur water, by the increased breaking up of the albuminous compounds, to which mercury is united in the body. The increased decomposition of albumen was proved, by the presence of an increased amount of urea in the urine. Güntz attributes, no doubt rightly, the increase and decomposition of albumen, to the increased supply of water. When he, at the same time, calls in 'the oxygen-withdrawing action of sulphur waters,' we cannot follow him in his hypothesis. Güntz believes also, that the diminution of the frequency of the pulse and of respiration, which occur during the use of sulphur waters, diminishes the supply of oxygen, and thus favours the decomposition of albumen. The syphilis poison, also, is said to be united to albuminates in the system. While the albumen breaks up in increased quantity, during the use of the sulphur water, the latent syphilis is brought to light, for the eliciting of syphilitic products is always accomplished at the expense of albumen. *Sapienti sat!*

There is no such thing, as a specific action of sulphur waters in chronic mercurialism. As copious water drinking, bathing and sweating, and bodily exercise, &c., are the active agents in the balneotherapeutic treatment of this condition, it is evident, that there can be no real difference between baths of different chemical composition. Everything depends on consecutive and methodic application of the measures. The attention, that has been paid to such matters at Aix la Chapelle and at some other baths, is repaid by the fact, that patients suffering from chronic mercurialism are usually sent to such baths, in preference to others.

The opinion is still widely spread, that the use of sulphur waters, especially of the warm ones, has a beneficial influence on syphilis. People expect from bathing and drinking, not only the cure of chronic mercurialism, the elimination of mercury from the system, but they also see in sulphur waters powerful reagents against latent syphilis. Its symptoms are said to be, as it were, aroused by these waters, and are then successfully subjected to a specific mercurial or to an iodine cure. No doubt warm waters often have the effect of promoting the localisation of syphilis on the skin. How often does one see, in torpid skin affections, roseola and other exanthemata appear, even after a few warm baths. That is an effect of the heat of warm baths: the hydrosulphuric acid is in such small quantity, that it cannot be supposed to act even as a stimulant to the skin. It also cannot be denied, that chronic products of syphilis, atonic ulcers, gummy infiltrations of the skin, periostoses, and also buboes are brought to heal by absorption, under the influence of warm baths. But all these good effects must be set down to the influence of the warm baths, vapour baths, and not to the infinitesimal amounts of sulphur present. The great reputation which some baths, and especially Aix la Chapelle, have acquired in syphilis, must, independently of the favourable influence of warm baths, be attributed to the energetic mercurial and iodine cures, which are carried out at such places. In truth, the bath physicians are apt to be not very particular about their diagnosis, but act on the principle, that *quisquis est syphiliticus, donec contrarium probetur.*

The employment, for hundreds of years, of sulphur in the form of sulphur ointments, solutions of alkaline sulphurets, sulphur floating in ether and alcohol, &c., in various skin diseases, the more lately discovered power of flowers of sulphur to kill certain funguses (for instance, that of the grape disease), probably by the development of sulphuric acid, the experience of its effect on the parasitic sources of scabies, favus, herpes tonsurans, sycosis, pityriasis versicolor, &c., all these causes have made the indication of sulphur baths plausible in the just named affections, and also in various other skin ones (eczema, psoriasis, acne, chronic cutaneous ulcers, &c.) But here also the minimal sulphur contents of the water can play no real part in the cure.

The sulphides of alkalies and earths, which have been intro-

duced into the stomach, are decomposed by the free acids, so that hydrosulphuric acid is formed; if the higher compounds of sulphur are present, precipitated sulphur is excreted. This decomposition often takes place in sulphur waters, outside the body, owing to the oxidation of hydrosulphuric acid by the air. Hence arises the cloudy, milky look of various sulphur waters. The sulphur, which is excreted in the stomach from the sulphur waters, is probably converted in the duodenum, where the reaction is alkaline, into alkaline sulphide, which may, in that form, be partially absorbed. The greater portion remains in the intestines, and is further down changed into sulphide of iron, and in the large intestine, in which there is often a weak acid reaction, partly changed again into hydrosulphuric acid. The alkaline sulphide exercises a slight stimulation on the mucous membrane of the stomach and intestines, promoting peristaltic action, and in large doses of 0·1 to 0·2 gramme of sulphide of potass may act as a laxative. This operation, however, seldom occurs during the use of waters containing sulphide of sodium, because even the strongest wells (for instance, the Franzenquelle at Herculesbad) contain at most 0·08 gramme of it in the litre.

It is further said, that sulphur, whether exhibited in the form of hydrosulphuric acid or as a sulphide, increases the secretion of the gastric juice, of the bile, of the pancreatic juice, and of the fluids of the intestines. There has been further assumed, from the experiments of Böcker and Eulenberg, an influence on conversion of tissue (an increase of the excretion of uric acid and of urea). All these assumptions stand in need of proof.

The hydrosulphuric acid, which has reached the blood, is partly eliminated through the lungs, perhaps partially through the skin. Another portion leaves the body through the urine, in the form of sulphuric acid, which is combined with potass or soda. But it has not been shown, whether also any increase of sulphuric acid in the urine is caused by the use of the ordinary quantities of sulphur waters; it is difficult to adduce proof of this, because, even supposing that the whole of the sulphur, which is swallowed in a litre of a popular sulphur water, were excreted through the urine, as sulphuric acid, the quantity of sulphuric acid, passed in the urine in the course of

twenty-four hours, would not show any observable variation from its normal amount, for it is only after poisonous doses of hydrosulphuric acid, that it reappears in the urine (Emminghaus, Betz), and sulphide of soda, given in large doses, passes away unaltered in the urine (Krause, Wöhler).

There is no doubt as to the permeability of the skin for sulphuretted hydrogen. The older experimenters, Chaussier, Lebküchner, Nysten, Madden, Orfila, showed, that animals that were dipped in hydrosulphuric acid, with the exception of their heads, died with the corresponding symptoms of poisoning. In later times, Röhrig has carefully repeated these experiments, and has completely confirmed them. Hydrosulphuric acid, absorbed in water, has also the same effect as the free gas. Röhrig bathed rabbits in water which was saturated at the temperature of 68° with hydrosulphuric acid, taking care that they continued to breathe atmospheric air. The animals died after eighteen minutes in the bath, with all the usual signs of poisoning by the gas. Although, on the ground of these experiments, we cannot doubt that the human skin may absorb the gas in a bath, yet the minimal quantity of it, that can eventually reach the blood, is not, in ordinary sulphur baths, of the slightest physiological or therapeutical importance. The idea of any powerful stimulation of the cutaneous nerves is also out of the question.

The therapeutic indications of sulphur waters, as we have not been able to attach any importance to their sulphur, in either their internal or external applications, coincide with the indications of warm baths and of copious water drinking. On this rests the indication of sulphur water in chronic rheumatism, in chronic joint affections, in metallic intoxications, in syphilis, in various skin affections, in the remains of traumatic inflammation, in paralyses, in neuroses, and in other diseases. The various incidents of bath life of course co-operate also.

We are not called on here, to enter closely into the application of these waters in their various forms of warm, hot, and vapour baths, of various douches (falling, ascending, alternation of hot and cold, called Scotch douches, douches of gas and vapour), further in the form of local and sitz baths, injections, gargles, fomentations, inhalations (gas, steam, *vaporaria*), &c.

Let us only be allowed one remark, that in the inhalation cures which are used at the different sulphur wells, the gases (hydrosulphuric acid, carbonic acid) are at best unnecessary and purposeless, perhaps rather injurious than useful. The effects, which one sees from inhalation cures, in chronic catarrhs of the respiratory organs, are practically the result of nothing else, than the continued inhalation of moist warm air. Dry inhalations of gases, which, at the sulphur baths, are hydrosulphuric acid and carbonic acid, are to be condemned totally. Many of the procedures carried on at such baths, belong to the large chapter of blind experiment and of speculation, and have gone so far, that, when we send patients to certain baths, we are obliged to give them letters warning them against some extravagant and senseless proceedings, which are nevertheless popular.

For sulphur-peat, and mud baths, see the Appendix.

TABLE VIII.—SULPHUR WATERS.

a. *Warm Waters.*

(Parts in 1,000 parts of water.)

Name of Spring	Situation	Sulphide of Soda	HS Acid absorbed in Water	100 Cub. Cm. of Gas rising from Water contain HS Acid	Relatively most Important Constituents	Temperature
Aix la Chapelle, Kaiserquelle	Rhenish Prussia	0·01	—	0·3	Chlor. sodium, 2·6; bicarbon. soda, 0·6; carbonic acid, 251	131°
Burtscheid .	Close to Aix la Chapelle	0·001	—	0·2	Chlor. sodium, 2·7; bicarbon. soda, 0·6; carbonic acid, 223	140
Landeck .	Silesia .	—	0·9	—	—	80·6
Baden .	Near Vienna	—	2·5	—	Carb. acid, 44	91·4
Baden .	Switzerland	—	0·6–1·7	—	Sulph. soda, 1·8; chlor. calc., 1·3; carb. acid, 66	114·8
Schinznach	„	—	37·8	—	Sulph. calc., 1·0	77–93·2
Lavey . .	„	—	3·5	—	Sulph. soda, 0·7	109·4–113
Herculesbad	Mehadia, Hungary	0·07	42·6	—	—	111·2
Harkany .	Hungary .	—	—	—	Carbonic oxysulphide, 6·8; carb. acid, 191	143·6

TABLE VIII.—SULPHUR WATERS (*continued*).

Name of Spring	Situation	Sulphide of Soda	HS Acid absorbed in Water	100 Cub. Cm. of Gas rising from Water contain HS Acid	Relatively most Important Constituents	Temperature °
Pystjan .	Hungary .	—	15·3	—	Carb. acid, 105	173·7
Warasdin .	"	—	4·9	—	" 152	134·6
Trenchin-Teplitz	"	—	1·4	—	Sulph. calc., 1·1; carb. acid, 193	104·0
Gross-wardein	"	—	276 ?	—	Sulph. sodium, 0·8; bicarbon. soda, 0·8	113·0
Bagnères de Luchon	Pyrenees .	0·07	—	—	—	154·0
Le Vernet .	"	0·04	—	—	—	119·7
Barèges .	"	0·04	—	—	—	111·2
Amélie les Bains	"	0·01	—	—	—	141·8
Eaux Bonnes	"	0·02	—	—	—	89·6
Cauterêts .	"	0·02	—	—	—	102 2
St. Sauveur	"	0·02	—	—	—	93·2
Aix les Bains	Savoy . .	—	27·2	—	—	114·8
			b. *Cold Springs.*			
Nenndorf .	Hesse . .	—	42·3	—	Sulphide calc., 0·06; sulph. calc., 1·0; carbonic acid, 173	53·6
Eilsen .	Lippe-Schaumburg	—	40·4	—	Sulph. calc., 1·7; carb. acid, 67	53·6
Weilbach .	Nassau .	—	5·0	—	Carb. acid, 262	55·4
Meinberg .	Lippe-Detmold	0·008	23·1	—	" 81	52·2
Langen-brücken	Baden . .	—	6·5	—	" 219	55·4
Gurnigel .	Bernese Oberland	—	15·1	—	Sulph. calc., 1·3; carb. acid, 334	46·4
Stachelberg	C. Glarus .	0·04	14·7	—	Carb acid, 108	48·2
Wipfeld .	Lower Franconia	—	35·1	—	Sulph. calc., 1·0; carb. acid, 129	55·4
Höhenstedt	Lower Bavaria	—	20·0	—	—	—
Sebastians-weiler	Würtemberg	—	13·0	—	—	—
Kreuth .	Bavarian Mountains	—	6·6	—	Sulph. calc. magn., 2·3; bicarb. calc., 0·9	51·8
Alveneu .	Albula V., Switzerland	—	0·9	—	—	—

Besides these, there are innumerable sulphur wells, many of them not yet analysed, which resemble, in their amount of sulphur, the waters enumerated above. There are few baths, where there is not a sulphur well, in addition to the chief springs.

9. THE EARTHY AND LIME-CONTAINING WATERS.

(See Table IX.)

Beneke: 'Z. Physiol. u. Pathol. d. phosphors. Kalkes.' Götting. 1850. —Id.: 'Z. Würdig. d. phosphors. Kalkes.' Marb. 1870.—Lersch: 'D. Fund. d. prakt. Balneol.,' 1868, p. 681.—Hoppe-Seyler: 'Med. chem. Unters.' Tüb. 1871.—Weiske: 'Ueb. d. Einfl. v. Kalk- und Phosphors. armer Nahrung auf d. Zusammens. d. Knoch.,' *Zeitschr. f. Biolog.*, 1871, part iv.—Forster: 'Ueber d. Bedeut. d. Aschebestandth.,' *Zeitschr. f. Biologie*, 1873, vol. ix.—Erwin Voit: 'Ueb. d. Bedeut. d. Kalkes f. d. thier. Organ.,' *Zeitschr. f. Biolog.*, 1880, vol. xvi. p. 55.—Stöcker: 'D. erd. Mineralq.,' in *Valentiner's Handb. d. Balneoth.*, 1876, p. 370.—Cantani: 'Path. u. Therap. d. Stoffwechselkrankh.,' vol. ii. Berl. 1880.—Fürbringer: 'Z. Oxalsäureausscheidung durch d. Harn,' *Deutsch. Arch. f. klin. Med.*, xviii. 1876.—Studensky: 'Jahresbericht f. Thierchemie von Maly,' 1872, p. 188.—Husemann: 'Der Kalk als Bestandth. d. Mineralquellen,' *Oesterr. Badezeit.*, 1878, Nos. 14, 17.—Id.: 'Das Chlorcalcium als tonisirendes Mittel,' ibid. 1879, No. 9.—Soborow: 'Ueb. d. Kalkausscheid. im Harn,' *Centralblatt f. d. med. Wissensch.*, 1872, 39.—Vogel-Neubauer: 'Analyse des Harnes,' 4th edit. p. 333.—Neubauer: 'Ueb. d. Erdphosphate d. Harns,' *Journ. f. prakt. Chem.*, vol. lxvii.—Brügelmann: 'Ueb. d. Wirk. d. N-Inhalat.,' reprinted from the *Verhandl. d. Gesellsch. f. Heilk. in Berl.*, Balneolog. Sect., 1880.

A number of springs, which contain no salts in any quantity, except the carbonate and sulphate of lime or magnesia, enjoy the somewhat poverty-stricken title of 'earthy waters.'

Nevertheless many common spring and well waters, which are daily used as ordinary drinking water, contain enough of carbonate of lime, or of gypsum, to entitle them to be classed as earthy waters. Such drinking waters are called hard and bad.

Many mineral waters (alkaline, Glauber salts, Epsom salts, iron and salt wells) contain as much (or more) of lime salts, as the earthy wells. Those 'nobler' waters generally manage to be silent about their earthy salts, and if the epithet 'earthy' is tagged on to their other qualities, it is merely for the sake of an empty title.

On the other hand, mineral waters, that are free from lime, and especially from gypsum, proclaim their immunity, and with good cause.

When it is the object to determine the value of earthy springs, according to their amount of earthy alkalies, it is usual to class lime and magnesia salts together. In this we proceed on the mistaken notion, that the actions of both are identical, and support each other.

The sulphate of lime of these wells usually passes for harmless ballast, and it is certain, that the greater part of it passes through the digestive canal unaltered. According to Husemann, sulphate has a much better chance than carbonate of lime of reaching the blood undecomposed. The latter is not absorbed as such, but after being converted into chloride of calcium, can be easily absorbed.

The phosphate of lime (the preparation of that substance which very properly is most used in medicine) occurs in the earthy waters, either not at all or in mere traces. Thus Leuk has 0·03 and Weissenburg 0·009 of phosphate of lime in 1,000 parts by weight of water.

Of late Husemann has called attention to the almost forgotten chloride of calcium as a tonic medicine. It is, as the experiments of Perl on dogs show, in great part altered in the intestinal canal, by the action of the alkaline carbonates present in it, into carbonate of lime, and as such passes out of the canal. A portion of the chloride of calcium is absorbed. In one experiment of Perl's $\frac{1}{25}$th, in another $\frac{1}{36}$th part of the quantity of lime introduced with the chloride reappeared in the urine. Still larger were the quantities of lime excreted through the urine, which Soborow found, after feeding men and dogs with chalk. Husemann explained this by a mechanical adhesion of the particles of chalk to the coats of the stomach.

The earthy wells, strictly speaking, are free from chloride of calcium. Some salt springs and brines, however, contain large quantities of it. [Notably British ones.—*Tr.*] Thus, the salt spring at Neuhaus, in N. Bavaria, contains 1·3, the Nauheim Kurbrunnen 1·0 of chloride of calcium in the litre. The wells in question are also full of other calcium salts, whose operation is certainly aided by the common salt present. Some brines, used exclusively as baths, are very rich in chloride of calcium. Thus the Beringerbrunnen at Suderode contains 15·1, the well at Hubertusbad 11·0 of that salt. But these, and other wells rich in lime, are not suited for drinking cures, on account of the large quantity of chloride of sodium which they contain. The idea of Husemann, to introduce the chloride of calcium of these springs by clysters, or by inhalation of pulverised brines, is a very

roundabout process, which is better attained by adding certain quantities of the lime to favourite salt waters, or, better still, by using a pharmaceutical preparation of it. Proposals of this kind make one think of the times, when very different properties were ascribed to the salts of mineral waters, than what were attributed to the surer doses of the chemist's shop.

If we have not been able, in the case of iron or sulphur wells, to discover the substances to which they owe their importance, we find ourselves in the same position, when we have to answer the question, On what physiological properties and effects, on what medical experiences, is the present therapeutical recommendation of earthy waters grounded? We may give so little scope to our scepticism, as to grant some play for the alleged facts of practical experience, and as to transfer the physiological facts concerning the use of lime, in nutrition, to the region of pathology; nevertheless we are driven to the conclusion, that the therapeutic worth of the carbonate and sulphate of lime of the earthy waters, is in the highest degree problematical.

The usual balneological descriptions of the earthy mineral wells, are apt to be very far-fetched. First, the importance of lime, as an indispensable portion of the frame and of nutrition, is insisted on. Next come the bad effects, described by physiologists, which have followed the prolonged withholding of lime from the system. These representations, obviously, have no bearing on earthy mineral wells; for the normal solid and fluid food of man contains considerably more lime than is wanted for the growing, or for the adult system. The excess supplied passes away, chiefly in the fæces, and this applies equally to the lime salts of the earthy wells.

The fact of lime being necessary for building up the body, has had the further conclusion tagged on to it, that an increased supply of lime is useful in a variety of cases, of 'defective sluggish development of the system,' of 'faulty constitution of blood,' of consumptive conditions, in weak anæmic scrofulous, and tubercular individuals, in order 'to promote a new formation of cells in the system.' As lime occurs in all organs, it is inferred, that it must be a necessary condition for the formation of cells, which is required, in order that the lowered system may return to its normal condition. It is scarcely necessary to point out

the error, which lies at the root of such conclusions; they show how little the 'quantitative sense' is developed in some.

It is usual to expatiate on the therapeutic value of lime in rachitis, when its medicinal virtues are discussed; and the earthy wells make free use of this indication, which lies so ready to hand. Yet no one has ever thought of sending rachitic children, in their first year, to baths, or of prescribing for them earthy mineral waters.

If rachitis of the growing organism, as must be assumed after the experiments of Roloff and Wegner, and the new beautiful experiments of Erwin Voit, arises from a deficient conveyance of lime to the bones, which are expanding in their organic structure, the want of lime must have its root, in some deficiency of power, in the digestive canal, to take up lime, as there is always an abundant supply of lime present in food. If in such cases the impaired power of the digestive canal to take up lime, could be cured by an increased supply of that substance, then lime would be a proper remedy for rachitis. This has often been assumed, and it has been said, that, as the carbonate of lime removes the excessive formation of acids, and the catarrh of the bowels coming on with diarrhœa, it restores the conditions of normal nutrition, and of assimilation of lime salts. But all this theory rests on a wrong foundation, and is not confirmed by the facts of experience. At the same time it must not be denied, that in a certain stage of rachitis, if the conditions for the absorption of lime have been restored, the cure may be accelerated by a larger supply of lime; but here, in this stage also, we prefer to pass by the lime waters, which generally contain gypsum, and to use more rational remedies, phosphate and chloride of lime.

The bicarbonate of lime, which is dissolved in mineral waters, is often first reduced in the stomach to carbonate, before it can be changed by the acids of the stomach into chloride or lactate of calcium. The greatest part of the carbonate of lime supplied, appears again in the fæces, as carbonate or as phosphate of lime. Lactate of lime is oxidised in the blood by carbonic acid; carbonate or phosphate of lime appears in the urine. A copious supply of lime, such as is only procured by an excessive use of the earthy mineral waters,

diminishes the acidity of the urine, and makes it neutral or alkaline; then the earthy basis, as Beneke showed, assumes a portion of the phosphoric acid of the phosphate of soda, to which, as is known, urine owes its acid reaction. The latter is reduced to neutral phosphate of soda.

Carbonate of lime acts as an antacid—that is, as counteracting the acids. On this account, earthy waters are recommended in cases of stomach catarrh, with excessive formation of acid. This indication can be fulfilled, with much greater certainty and ease, by ordering the soda waters, which act much more mildly on a sensitive stomach, than the hard, gypsum, earthy waters.

The action of the salts of lime is proclaimed, 'as limiting secretion,' 'drying up,' 'styptic;' powers ascribed to the antidiarrhœal, constipating effects of these waters. They are supposed to be particularly useful in diarrhœa accompanied with catarrh of the bowels.

It has been supposed, that their drying-up action may be useful also in other affections of the mucous membrane, as those of the pelvis of the kidney, and of the bladder in chronic catarrh, in blenorrhœa of these organs, and even of the mucous membrane of the respiratory tract. Thus earthy waters are prescribed in catarrhs of the respiratory organs with profuse secretion. We cannot let this last observation pass without comment.

Certain earthy wells have a considerable renown, especially those of Wildungen, of the Hesterquelle, in Driburg, and of Contrexéville, in the treatment of chronic bladder catarrh, nephropyelitis, &c. We cannot imagine a direct action of the carbonate of lime of these waters, as only a small portion of it passes into the urine. If these waters deserve the reputation which they have acquired, solely from their therapeutic use, it depends chiefly, if not entirely, on the increased supply of water, and on the carbonic acid which they contain, although balneologists wrongly attribute a diuretic action to carbonate of lime.

The recommendation of lime-containing carbonated waters, like those of Wildungen, in calculi of the liver and bladder, can only rest on the favourable action of increased water drinking, and perhaps slightly of the carbonic acid, if lime calculi are

present. Such wells would do wisely to conceal their amount of lime, for it can only help to increase the size of the calculus, by the precipitation of its salts on it. I refer only to the experiments of Studensky, who, when he introduced foreign bodies into the bladders of animals, immediately observed the formation of stone, when he gave them water to drink strongly impregnated with lime. Whenever there is even a suspicion of calculi in catarrhs of the kidneys or bladder, calcareous waters are to be shunned. This is also the case when oxalate calculi are present; for, apart from the possibility of precipitation of lime on the stone already formed, the excessive supply of carbonic acid, in most calcareous waters, might at least, according to the older theories, increase the formation of oxalic acid. But it deserves to be mentioned, that neither Cantani, with the use of carbonated drinks or of lime water, nor P. Fürbringer in his experiments with lime water, could detect any such increase of oxalic acid.

Starting from the widely spread, but even yet not proved assumption, that the excretion of lime in the urine is increased in osteomalacia, in caries, in necrosis of the bones, in profuse suppuration, in chronic pulmonary tuberculosis (Senator), in other consumptive conditions (Beneke), the use of calcareous waters has been recommended, to cover the increased loss of lime. It is unnecessary to criticise what can be so easily refuted.

I find it no longer stated, in modern balneological literature, that the calcareous waters favour the 'retrograde metamorphosis,' the calcification of exudations, the conversion of tubercle into a cretaceous substance.

It is plain, that in using earthy waters for baths, the amount of lime is of no importance, or at most may act as a slight stimulant to the skin. What we have said above (pp. 367, 368) of the action of the carbonic acid of baths, applies to the carbonated baths of Wildungen, and of Inselbad. In the thermal earthy well of Leuk, excellent effects are produced by the method pursued there of prolonged immersion, of several hours, in certain chronic exanthemata (psoriasis, pruritus, &c.), in atonic ulcers, and in gouty and rheumatic affections. In these prolonged baths the lime plays a very secondary part.

Of the places with earthy wells, Lippspringe and Inselbad, near Paderborn, the first lying on a sandy plain, make pretensions to be climatic stations for the cure of consumption, and of chronic affections of the organs of respiration. The climatic claim must be referred to the author of the climatology in this work. I shall only allow myself one remark, that the different 'sanatoria for chest affections,' in most different places, and under most various climatic conditions, all of which boast of such wonderful cures, prove this; that successful results may be obtained everywhere, and I do not hesitate to say, as much in the north as within the tropics, by increased staying in the open air at certain seasons of the year, by judicious regulation of the mode of life and nourishment, by strictly attending to certain hygienic rules, by removal from injurious influences present in the homes of patients, by stimulating the activity of the skin (by douches, cold baths, &c.), by 'gymnastics of the lungs,' milk cures, &c. Although the recognition of this in no ways tends to lessen the high value, ascertained by long experience, of the climatic winter resorts of Switzerland, Italy, and Egypt, yet, on the other hand, it throws a true light on the great renown, which many of the sanatoria for chest complaints have of late years attained by artificial means. Many of those places owe their reputation to the circumstances which we have enumerated, rather than to their climates, of which they often have no cause to boast.

At some stations with earthy wells, as Lippspringe and Inselbad, whose waters are rich in nitrogen, inhalations form an important curative agent in chronic affections of the organs of respiration, and especially in phthisis pulmonalis. Graduating works (already explained) through which the water trickles, are used in the inhalation rooms of these places; a quantity of water evaporates, and the gases are set free. The favourable effects, which patients with catarrhs of the respiratory organs experience, from staying in the inhalation room, may be ascribed solely to the increased moisture of the atmosphere. But some consider the abundance of nitrogen in the air inspired to be a far more important agent. The increase in the respired air of nitrogen, which is respiratorily indifferent, can only act indirectly, so far as such air is poorer in oxygen. On this ground, the mere passing stay in one of those inhalation rooms is compared to staying at elevated health stations (!). Here, as there, it is said, that the smaller volume of oxygen in the air inspired leads to deeper inspirations, and that a part of the beneficial influence depends on this 'exercise of the lungs.' Besides this, it is asserted, that the air of the inhalation room rarefied, poorer in oxygen and richer in nitrogen, is much less 'hard

and irritating' than normal air (?). If Brügelmann observed, in patients sitting before his graduating works, after only an hour, considerable decrease of cough, and a remarkable 'soothing of the excited nervous system,' neither the increased amount of oxygen, nor the diminished one of nitrogen, had anything to say to this; the factor was the great moisture of the air inhaled. The soothing of the nervous system is the direct effect of the quieting of the cough.

TABLE IX.—THE EARTHY MINERAL WATERS.

(Parts in 1,000 parts of water.)

Name of Well	Situation	Bicarbonate of Calcium and Magnesium	Sulphate of Calcium	Free Gases in Water	Gases rising from the Water in	Relatively Important Constituents besides Earthy Salts
Wildungen, G.-V.-Quelle	Waldeck .	1·2	—	Carb. acid, 1,322	Carb. acid, 993; nitrogen, 6	—
Driburg, Hesterquelle	Westphalia .	1·5	1·0	Carb. acid, 1,043	—	Sulphate mag., 0·8
Lippspringe, Arminiusquelle	" .	0·6	0·8	Carb. acid, 166; nitrogen, 6	Nitrogen, 824; carbon. acid, 149; oxygen, 26	Sulphate soda, 0·8
Inselbad, Ottilienquelle	Near Paderborn	0·5	—	Carb. acid, 461; nitrogen, 216	—	Chlor. sodium, 0·7
Leuk . .	Canton Wallis, Switzerland	—	1·5	—	Nitrogen, 934; carbon. acid, 51	Temp., 123·8°
Weissenburg	Canton Bern, Switzerland	—	1·0	—	—	Temp., 78·8°
Contrexéville	Vosges, France	1·3	1·1	—	Carb. acid, 59; nitrogen, 30	—

APPENDIX.

1. *PEAT AND SLIME BATHS.*[1]

P. Cartellieri: 'Franzensbad. Mineralmoorbäder.' Prague, 1852.—Lersch: 'Hydrochemie,' Bonn, 1870, p. 625 ff.—Kisch: 'Z. therap. Würd. d. Moorbäder,' *Jahrbuch f. Baln., Hydrol., Klimatol.*, vol. i. 1874.—Valentiner: 'Handbuch d. Balneotherapie,' 2nd edit. p. 442.—Jakob: 'Entstehung, Bereitung u.s.w. des Moores,' *Verhandl. d.* 4. *Schles. Bädert.*

The bog or peat earth, which is used at many bathing places, especially at iron and sulphur wells, is a sort of turf which is formed by the decomposition of plants, with the aid of mineral deposits of various kinds. Hence the name of mineral peat earth, which, according as it contains sulphates, iron or sulphide of iron, sulphide of ammonia and hydrosulphuric acid, is distinguished as saline, iron, or sulphur peat earth. The constituents of this earth are the constituents of humin (crenic acid and humin), resins, vegetable remains in various stages of decomposition, silica, mica sand, alumina, lime, magnesia, oxide of iron, phosphate of oxide of iron, sulphide of iron, sulphates of potass, soda, and magnesia, chlorides of the alkalies and earths, free sulphuric acid, sulphide of ammonia, and, further, a few gaseous elements, hydrosulphuric and carbonic acids. In peat earth, that has been exposed to warmth, there occur, further, formic and acetic and other volatile acids.

We possess numerous analyses of different kinds of peat earth. There are great differences of composition, not only in peat earths of different localities, but in different portions of the earth from the same place, which can scarcely interest the chemist or geologist, much less the physician. There have, indeed, not been wanting attempts to ascribe specific bath actions, or at least specific indications for the different earths.

The peat earth is usually brought into contact with mineral

[1] *Die Moor- und Schlamm-Bäder.* These baths, of two kinds, as explained in the text, are usually called 'mud baths,' or 'moor baths,' in English works. There is no very good English equivalent for 'Schlamm.'—*Tr.*

waters, chiefly to increase the amount of its salts, or is exposed to the weathering of the air, in order that the organic matters may be oxidised, and various insoluble mineral constituents may be changed into soluble sulphuric, acetic, or formic acid salts.

When that compound mixture, which is always varying in its composition, and known as peat, is thrown into warm bath water, a certain amount of the contained salts is dissolved, while the main portion of the insoluble compound yields to the bath a mass varying from a thin broth to a thick smeary stuff in consistence, according to the quantity of peat earth that has been added. Specific actions are ascribed to peat baths, according to the quantity of dissolved constituents, and of iron, sulphur, &c. It has been supposed, that these baths influence various physiological processes, as the respiration and the circulation, the pulse, the production of heat, the heat of the body, the change of tissue, the secretion of urea, &c., and influence them specifically—that is, in a way different from the action of simple warm water or skin-stimulating brines. I shall spare my readers the refutation of the 'researches,' which have arrived at such wonderful results. The literature of peat baths, with few exceptions, takes an exaggerated view of their therapeutic action; and the attempts made to explain these actions, are marked by the construction of bold, and at the same time wonderfully simple hypotheses.

We can discover nothing more in peat baths, than warm or hot baths, which contain various skin-stimulating substances. They therefore resemble, in their operation and indications, other skin-stimulating baths—for instance, brine, and, further, lye baths—and are applicable where the object is, to bring to resolution chronic stationary exudations, and to do the same in rheumatic and gouty affections of the joints, muscles, and sinews, in chronic exudations in the pelvis, as metritis chronica, peri- and para-metritis, in neuralgias (sciatica), in certain, especially peripheral, paralyses, in contractions and ankyloses, in certain skin affections, &c.

Poultices of peat earth are perhaps distinguished, by a somewhat higher power of stimulating the skin, from the cataplasms of ordinary practice, with which they have common indications.

The slime employed for making the closely allied, so called slime baths, is the deposit of organic remains of low animal or vegetable forms of life, as well as the deposit of inorganic matters from rivers (I remind my readers of the famous Nile mud), from lakes, and also from mineral springs. The bath mud is particularly rich in the salts of the spring from which it has been thrown down.

The sea mud deposited in bays with clay bottoms, is also used for mud baths in some places.

In many sulphur baths, baths of peat earth saturated with sulphur water, are used, as sulphur peat baths. The sulphur slime of sulphur baths, which consists of the remains of plants and organic products of decomposition, of humic acid, lime, alumina, and silica, and which also often contains sulphur and hydrosulphuric acid, is also employed for preparing sulphur mud baths. Of course the sulphur has no more to say in the effect of these baths, than iron has in that of the iron peat baths; and what we have said above, about peat earth baths, applies equally to sulphur mud baths. Peat baths are in use nowadays at an immense number of baths, besides sulphur and iron ones. Therapeutically, no differences are known between the mud baths of different places.

I mention specially, among iron peat baths, *Franzensbad* and *Marienbad*, where the method of using these baths has been perfected, by unusually extensive employment of them. Besides these, I may name *Brückenau*, *Bocklet*, *Elster*, *Pyrmont*, *Reinerz*, *Steben*, &c.

Nenndorf, *Eilsen*, *Wipfeld*, *Driburg*, are the most noted of the sulphur peat and sulphur slime baths.

The iron peat salt, which is for sale, is a very expensive article, which can well be dispensed with.

2. *PINE-LEAF AND HERB BATHS.*

The product, got by steam distillation, and a decoction of the leaves of pines, are employed in many bathing places and health resorts, for the preparation of pine-leaf baths. The first contains ethereal oils, the last chiefly resins, organic acids, turpentine, formic acid. These baths belong to the skin-stimulating ones, with which they have a common action and indication. Specific operation can scarcely be ascribed to pine-leaf baths, but it is beyond question that the volatile (ethereal) constituents of these baths penetrate the epidermis, and may be taken into the blood. They are then eliminated again, through the lungs and skin, and in part through the urine. We have no detailed information about these volatile substances, which are absorbed quite in minimal quantity, however. These pine-leaf baths are in especial favour as 'powerful tonics.'

What we have said of these baths holds good also of other aromatic or herb baths, which are prepared from 'hay flowers,' or from camomile, gentian, calamus, mentha, juniper, marjoram, &c.

Pine and herb baths are prepared at many baths and hydropathic establishments; they are specially used in the mountain baths (Hartz, Thuringia, &c.)

Some cold water cures, offering opportunities for pine-leaf baths, are *Alexanderbad*, in Bavaria; *Cleve*, on the Lower Rhine; *Dietemühle*, near Wiesbaden; *Elgersburg*, near Arnstadt; *Ilmenau*; *Johannisberg*, on the Rhine; *Kreischa*, near Dresden; *Liebenstein*, in Thuringia; *Nassau*, on the Lahn; *Nerothal*, near Wiesbaden; *Schweizermühle*, near Pirna; *Ruhla*, in Thuringia, &c.

Other establishments are *Blankenburg*, *Eisenach*, *Berka*, *Rudolstadt*, *Friedrichsroda*, *Brotterode*, in Thuringia; *Blankenburg*, *Grund*, *Ilsenburg*, *Thale*, *Andreasberg*, in the Harz; *Braunfels*, near Wetzlar; *Gleisweiler*, in the Palatinate; *Humboldtsau*, near Breslau; *Berneck*, near Baireuth; *Langenberg*, near Gera; *Karlsruh*, in Upper Silesia; *Johannisthal*, near Berlin; *Ottenstein*, in the Saxon Erzgebirge, &c.[1] Pine baths are further prepared at many baths, as at the brine stations of *Arnstadt*, *Salzungen*, *Schmalkalden*, *Sulza*, further at *Hofgeismar*, *Liebenstein*, and in many other places.

For domestic preparation of pine baths may be recommended the extract prepared at pine bath establishments ($\frac{1}{2}$ to 1 lb. for a bath), or the extract of Pinus sylvestris, to be had at Simon's laboratory in Berlin, of which half a bottle is enough for a bath.

Aromatic herb baths are prepared with 1 to 2 lbs. of camomile flowers, or aromatic spices $\frac{1}{2}$ lb., or with an infusion of 2 lbs. of calamus root, or of elder flowers, or of leaves of Mentha crispa, or of herb marjoram, or of juniper berries, &c. The simplest and cheapest material for such baths is to be found in the 'hay flowers.'

3. *SAND BATHS.*

Flemming: *Deutsch. Klin.*, 1874, No. 18.—Runge in 'Valent. Handbuch,' 2nd edit. p. 545.—Sturm: *Correspond.-Bl. d. Thür. ärztl. Ver.*, 1874, 8.—Flemming: *Oesterr. medic. Badezeit.*, 1878, No. 10.

The old popular remedy of the warm or hot sand bath, which was chiefly used on the sea shore, has of late years been adopted, in medical institutions, as a 'methodical and rational' procedure.

The patient is enveloped, in a lying posture, in a chest, either totally, with the exception of head and chest, or locally, according to the seat of his ailment, with sand of the temperature of 118° to 127°, and remains for an hour or longer exposed to its influence, and after that he is cleansed by a warm bath, and then is cooled down. Even higher temperatures are used in local baths. An arm bath, for instance, is usually taken at the temperature of 122° to 131°, a half-

[1] This enumeration is taken from Braun's *Lehrbuch d. Balneologie.*

bath at that of 122° and lasting a full hour, a general bath at a temperature of 116° to 118°, and lasting for at least half an hour. Certain procedures of the cold water cure, or other baths (brine, pine-leaf), are often associated with the sand baths.

The temperature of the body of the bather rises rapidly, and copious sweating sets in. But the sand bath can be borne hotter, and for a longer period, than a hot water or vapour bath. This depends partly on the slow heat-conducting power of the warm sand bath, and primarily on the transpiration from the skin continuing in the hot dry sand bath.

The loss of perspiration is said to be greater *cæteris paribus*, than in a vapour bath (?). The advantage is also proclaimed, of being able to treat the ailing part alone (for instance, in sciatica, muscle or joint rheumatism) with hot 'sand cataplasms.' Careful observations of the temperature of the body in these sand baths, are required in this very active mode of treatment, if injurious consequences are to be avoided. The contra-indications of these baths are obvious.

It is very doubtful, whether these sand baths have any special advantages, or different indications from vapour and hot air baths.

The indications for sand baths are the same as for warm and hot baths, peat baths, &c.

4. *TAN, MUSTARD, MALT, BRAN BATHS.*

A 'good tan bath' contains the decoction of 2 to 3 kilos. of tan (=250 grammes tannin) in 250 to 300 litres of water (a warm full bath). Mustard baths are made by adding 100 to 250 grammes of mustard powder to the bath. While these baths have undoubtedly the power of stimulating the skin actively, the so called 'demulcent, sheathing, quieting' baths of bran, of malt, and of glue, and the so named 'nourishing baths,' *horribile dictu*, of soup, milk, whey, and flesh extract, can obviously possess no action beyond that of the warm bath.

5. *WHEY, KOUMISS, AND GRAPE CURES.*

It is usual, in treating of whey and koumiss cures, to consider milk cures also, and further to place the last on the same footing as the two former. I should not wish to see milk for a moment placed in comparison with these very doubtful whey cures, considering that it is a most important and complete form of nourishment, and, in consequence, of the greatest dietetic value—nay, is often the most important curative agent in numberless diseases.

At many mineral water and climatic stations, milk is not employed as systematically as might be desired; and at many stations, where the physicians quite appreciate the value of milk, the old habit is maintained of getting the milk fresh from the cow, and of drinking it in the cow house; in all which there is supposed to be special virtue. But fresh milk is not borne by many stomachs so well as boiled, especially by those who have stomach affections. By boiling, the milk loses the animal smell, and the taste of fresh-drawn milk, which is not very pleasant. Boiling it also fulfils an indication of prophylaxis, by destroying any injurious matters which may be present in the milk.

Several baths and climatic resorts, undoubtedly owe a portion of their success to the increased quantity of milk drunk at them. This is especially the case in the treatment of pulmonary phthisis, anæmia, chlorosis, and various chronic disorders connected with consumption.

The whey[1] is the serum of the milk, which remains behind, after separating from the casein and the fat, and consists chiefly of water (93 per cent.), milk sugar (5 per cent.), and salts $\frac{1}{2}$ per cent. But small amounts of albuminates (1 per cent.), and of fat, still remain behind in the whey. The albuminates are absent only from the doubly clarified whey. The coagulated casein encloses the phosphated earths and the iron; therefore those salts are wanting in whey. A part of the milk sugar has changed into lactic acid. The cloudiness of whey is caused by the suspension of casein fats in it. The clearer the whey is, the less casein or fat does it contain.

Whey is usually prepared by adding a small quantity of the extract of the stomach of a calf, which is rich in pepsin—usually two or three weeks old (rennet)—to fresh milk warmed up to 120° to 126°. The milk of cows, of goats, and of sheep is used for whey (sweet or pepsin whey.) If the milk is allowed to stand and turn sour, or if the coagulation of the casein is produced by the addition of acids or of acid salts, then we have sour whey. In former times whey made with alum, or with cream of tartar, was largely employed in medicine. The second clarifying of whey, by which the albuminates remaining in it are got rid of, is made by heating the whey and adding a little sour whey to it.

Among salts, those present in largest quantities are chloride of potass, chloride of sodium, phosphate of potass and of soda.

The analyses of the cow whey at Obersalzbrunn showed, according to Valentiner—

[1] Beneke, *D. Rationalität der Molkenkuren*, Hanover, 1853: Falck, *Molken in Obersalzbrunn*, 1849; Lersch, *D. Kur mit Milch*, Bonn, 1869; Pletzer, 'Ueb. Molkenkuren,' *Zeitschrift f. prakt. Heilk.*, Hanover, 1866.

In 1,000 parts	Whey	Cow Milk[1]
Water	932·6	878·5
Albuminates	10·8	5·0
Milk sugar	51·3	40·0
Fat	1·2	35·0
Salts and extractive matter	4·1	6·5
Casein	—	35·0

The sweet mawkish taste and smell of whey is disagreeable to many, and takes away their appetite. The use of it, especially when, according to the rules of a cure, 1 to 2 pints of it are drunk, often excites dyspeptic conditions, or increases them if they are present already. Stomach and bowel catarrhs, with diarrhœa gripings, and their further consequences, often occur, especially if people continue their ordinary diet, along with the use of the whey.

Pretty frequently, whey acts as a laxative, owing to the milk sugar (4 to 5 per cent.), and chloride of sodium (half per cent.), which it contains. In this point of view, whey cures are regarded as equivalent to the use of laxative mineral waters, and as fulfilling the same indications. Whey cures are therefore recommended for chronic dyspepsia, for bowel catarrhs, for habitual constipation, for 'abdominal plethora,' for 'congestions of the lower bowel,' also for fatty liver and obesity. Whey cures, which take away the appetite and produce diarrhœa, are abstraction cures. But all these just mentioned indications are much better fulfilled, by ordering the alkaline Glauber salt, the chloride of sodium, or the bitter salt waters, as they act beneficially on the stomach and the bowels, which cannot be said of the whey. At the same time that our attention is called to this abstracting power of whey, and thus to its efficacy in reducing 'over-nourishment,' we are told, that it is an excellent article of nutrition. On this is grounded its recommendation in pulmonary consumption, in scrofula, in various conditions of imperfect nutrition. The nourishing power of whey is represented by its milk sugar, its albuminates, its fat, and its salts (those useful for nutrition). But there can be no question, that milk, which is richer in the elements of nutrition, is to be preferred for such purposes to whey. Methodical milk cures produce, in suitable cases, an increased putting on of fat, with an increase of the weight of the body, and an improved state of nutrition. It is entirely irrational to prefer whey, which is poorer in elements of nutrition, and which often excites dyspepsia and diarrhœa, to milk, which is much more easily borne by the stomach, tastes better, and is more nutritious. It is only in exceptional cases, when the whey is better borne by

[1] Compare an analysis of cow milk by Kirchner, *Beitrag z. Kenntniss d. Kuhmilch.* Dresden, 1877.

the stomach, that it can be compared with milk. One need not object to this, that the bodily weight and general state of nutrition improve at whey cures in the mountains. The same effect, to say the very least, can be obtained, in the same places, by the use of milk. Many whey cures owe their success to the milk drunk during them, as well as to the climatic and dietetic factors of a mountain residence, but very little, or only in the very slightest degree, to the whey itself.

Such statements, about the nutritive power of whey, are found in some writings on the subject, as show, that the first elements of the physiology of nutrition have not yet reached their authors.

Whey can replace a portion of the carbon hydrates required for nourishment, the albuminates, and fats; but it remains at least doubtful, whether this replacement takes place in a suitable form.

The increased supply of carbon hydrates (the milk sugar of the whey) may, along with a sufficient supply of albuminates, favour the putting on of fat. Many therefore believe, that 1 to 2 quarts of whey daily, are sufficient to increase materially the production of fat; hence one of its recommendations, in pulmonary and in other consumptive conditions. The erroneousness of such conclusions is plain. The putting on of fat is occasioned, not by the whey, but by the quantity and quality of the whole nutriment offered to the system, inclusive of the whey. Whey has no specific action, which increases the formation of fat.

I shall not speak here of other effects of whey in certain diseases, —of its 'cooling, antiphlogistic, solvent, absorption-favouring, cell-creating,' and other similar wonderful virtues. The great reputation, which whey acquired in the treatment of tubercular affections, dates from the time, when the convenient division of nutritive elements into plastic and respiratory prevailed. In those days, it was very natural that the whey, rich in sugar, should 'lighten the respiration, increase the process of combustion, and thus act favourably on affections of the lung tissue.' It is not necessary to point out the long series of erroneous assumptions, and of the conclusions founded on them, which are to blame for such superficial views.

Warm whey owes its reputation in catarrhs of the respiratory organs, to its warm water. Its indication, in 'abdominal plethora,' in hypochondriasis, and in chronic bowel catarrhs, rests, as has been already said, on its slightly laxative properties. Whey is diuretic, in so far as it represents drinks containing salts.

All these last-named indications are better fulfilled, more safely, and more rationally, by the use of alkaline muriatic, or Glauber or bitter salt drinking cures.

The great name, which whey once had in the treatment of different diseases, at particular stations, is dispelled by the criticism of better days. Whey belongs to the class of remedies, that are growing obsolete, but which will, nevertheless, retain their place in popular estimation, at many a cure station, for many a day to come.

Whey cure establishments are to be found at almost all cure stations. Warm whey is often employed to dilute certain mineral waters (acidulous, iron, and soda waters), a mixture against which the taste of the patient fortunately rebels.

Of the whey cures the following are best known : in Switzerland, those at *Gais*, *Heinrichsbad*, *Weissbad*, *Interlaken*; further, *Rehburg*, in Hanover, *Streitberg*, in Franconain Switzerland, *Gleisweiler*, in the Palatinate, *Salzbrunn*, *Kreuth*, *Reichenhall*, *Ischl*, *Liebenstein*, *Alexisbad*, *Reinerz*, *Schlangenbad*, *Ems*, *Meran*, *Montreux*, and many others.

Koumiss [1] is milk, which has undergone alcoholic fermentation. It is well known, that milk sugar is not easily made to undergo alcoholic fermentation by means of yeast. It may, however, be produced by letting the milk stand long, by frequently shaking it, and by adding a good deal of yeast. If carbonate of lime and rotten cheese are added to milk sugar, alcohol and lactic acid are formed.

If milk sugar is heated with diluted acids, it takes up water, and is converted into galactose, a body similar to milk sugar, and which is directly capable of fermentation. The use of the ferment called *Kor*, which is got from the alcoholic fermentation of milk, induces alcoholic fermentation of milk the quickest. The milk of mares appears to pass with peculiar facility into alcoholic fermentation, and it is the *Milchwein* prepared from this source, by the Kirgises and the Nogaies, that has specially the name of koumiss.

The recommendation of this drink, which was wonderfully exaggerated and enthusiastic, as being a 'stimulating, nerve-strengthening article of nourishment,' has not stood the test of critical examination, and the reputation of koumiss, in the treatment of consumption, has declined as rapidly as it sprang up. The fact that consumption is not known among the population of the Steppes, had led to the very naïve conclusion, that this must be owing to the use of koumiss.

Grape Cures.—The most important constituent of the juice of the grape is the grape sugar. The amount of it varies, as is well known, according to the variety of grape, the locality, the period of the year, very considerably—indeed, from between 8 to 20 per cent. Besides it,

[1] Lersch, *Die Kur mit Milch u.s.w.*, p. 26 ff. Bonn, 1869.

grape juice contains free acids (racemic and malic) and salts (tartrates of potass and lime, small quantities of phosphate and sulphate salts, and chlorides), further albumen, legumin, tannin, resin, gum, dextrin, &c.

The operation of grapes, as employed in a grape cure, in which 1 to 8 lbs. of grapes are eaten, partly on an empty stomach, and partly throughout the day (the skins and stones of course not being swallowed), or when an equivalent amount of squeezed-out juice is drunk, affects the intestinal canal chiefly. Their purgative action is the one, from which benefit might, on rational grounds, have been expected. The grape cures must be regarded as abstraction cures, which have however the disadvantage of throwing a heavy burden on the stomach and bowels, and of not rarely inducing catarrh of those organs. A strong stomach, a good digestion, a sound constitution, are therefore necessary conditions for the grape cure being permissible. It is not worth while to go into the usual phrases of the 'high nutritive power,' the 'tissue-converting influence,' &c., of grape cures. 'Pure faith' can afford no explanation of how this cure operates in consumption and bronchial catarrh, and scientific examination is not more successful. The indication for its use, in catarrhs of the bladder, and in urinary and renal calculi, and in gout, is grounded on the fact, that racemates and malates of potass appear in the urine, and render that secretion neutral or alkaline, an indication which is fulfilled much more easily and safely by the use of alkaline waters. One may best judge as to there being any rational foundation for the grape cure, when one observes how consumption and obesity figure together, in the most friendly fashion, in its programmes. Some of the best known grape cure places are *Meran*, *Bozen*, *Dürkheim*, *Neustadt* a. Hardt, *Gleisweiler*, in the Rhine Palatinate, *Montreux* and *Bex*, on and near the Lake of Geneva, *Grünberg*, in Silesia, &c.

ARTIFICIAL MINERAL WATERS AND BATHS.

When the composition of mineral waters became known, through competent chemical analysis, and the cloud, which had previously enveloped natural healing wells, began to disperse, the desire soon sprang up to procure cheaper and artificial substitutes for the expensive mineral waters, which were sent from long distances. Struve, the founder of the manufacture of artificial mineral waters, whose treatise on the imitation of mineral waters appeared in 1824, deserves the credit of having contributed to the knowledge of the composition of mineral

waters by a great number of careful analyses, and of having been the first to carry out successfully their artificial imitation. Struve's object at first was, to reproduce exactly all the constituents of mineral waters, and at that time he endeavoured to include the (physiologically and therapeutically indifferent) minute quantities which might happen to be present, often in such small quantities that they could have no real operation. At a later period, when he convinced himself, that only a few more prominent salts and gases were the active agents in mineral waters, he introduced an important simplification of their manufacture. He confined himself to the qualitatively and quantitatively most important salts and gases, and threw overboard the ballast of various insignificant constituents, which only increased the cost of the waters.

Ewich went a step further, in composing, on therapeutical principles, various mineral waters, which contained, in suitable doses and form, different substances which occur in natural waters, only in unimportant quantities, as iodine, bromine, and lithium. Struve had preceded Ewich so far in this direction, in having manufactured his soda waters, and his carbonated Glauber salt and magnesia waters.

Artificial waters, carefully prepared in imitation of natural ones, are quite equal to them in their therapeutic action. As they are usually much cheaper than exported mineral waters, they are, in that sense, to be preferred to them. A further advantage of artificial waters is, that they do not contain a useless ballast of inoperative or injurious constituents, which are often present in natural water, such as gypsum, silica, alumina, &c., and that, from the large amount of gas with which they are charged, they not only are pleasanter to the taste, but are borne better, and probably more easily absorbed, than the natural waters.

Nevertheless, the simple belief in the wonderful powers of natural waters is still widely spread among the laity; the opinion is still maintained in certain special medical circles, that the curative effects of drinking and bathing cures depend on certain unknown mysterious qualities, residing in the waters, which are beyond the reach of chemical analysis. These reasons, and the systematically carried out advertising, will secure the chief place in the market to the natural waters, for a long time to come.

If artificial waters are to come up to the requirements of medical men, and to be successful in their competition with natural waters, they must fulfil the following self-evident conditions. These are—

1. The purity of the water. Distilled or rain water, or at least pure well water, must be employed. When the water, used for the

manufacture of artificial waters, is taken from pumps in the midst of crowded cities, such waters may contain all the dangers which attend the use of impure waters, containing organic products of decomposition, not to say infectious matters.

2. The cleanness of the chemical apparatus employed in making the waters, especially of the materials employed for the generation of carbonic acid.

3. Those artificial waters only can count on the approval of medical men, about which no secret is made as to the mode of manufacture, or as to the constituents of the water. If artificial waters are to compete with natural ones in medical practice, they must, like the others furnish, adequate analyses of their contents, as a certificate. Every kind of mystery, all coining of titles, such as 'gout waters,' 'waters for hæmorrhoids,' &c., is enough, although the water may be quite properly manufactured, to set the physician against them, and to make him class them with the other popular remedies against all possible diseases, which figure in newspaper advertisements. Of course the same thing applies to the numberless offensive announcements of the marvellous properties of the natural waters.

We shall now enumerate some artificial waters, giving their chemical composition.

The most used of all the artificial waters are the pleasant, refreshing drinks, known by the name of soda water.

The soda water manufactured by Struve, contains 2 parts of bicarbonate of soda in 1,000 parts by weight of water, and is filled with carbonic acid under a pressure of four atmospheres: therefore there are four volumes of carbonic acid in one of water. Numberless establishments furnish similar soda waters.

Vetter's natrokrene, formerly a very popular soda water, contains, as made in Struve's laboratory, 2·5 parts of chloride of sodium, and 6·6 of bicarbonate of soda, in the 1,000 parts by weight of water.

The other alkaline, and alkaline muriatic acidulous, waters produced in Struve's manufactory (artificial Selters, Ems, and others), as also the Apollinaris water prepared by Ewich, are faithful imitations of the natural waters.

But even the artificial waters are often too dear for use in practice among the poor, and in many cases artificial mixtures of salts commend themselves, for the preparation at home of mineral waters. For a long time I have made use of various mixtures of this kind. Thus I substitute for Ems water, a salt consisting of 2 parts of bicarbonate of soda and of 1 of chloride of sodium. A full teaspoonful of this dissolved in a litre of water, and drunk lukewarm, with or without the

addition of milk, or used for inhalations or for gargling, is an efficient substitute for Ems water.

The artificial Carlsbad salts enjoy a great repute among the artificial salt mixtures, which serve for the preparation of artificial mineral waters. It is, for various reasons, to be preferred to the natural Carlsbad *Sprudel* salt, which is supplied under the supervision of the civic authorities. In the first place,[1] the artificial salt is a great deal cheaper than the natural one; one kilo. of the *Sprudel* salt costs thirteen shillings, while the same amount of the artificial costs only about fourpence.

But the artificial salt is to be preferred, not only on account of its price, but because it alone contains the chief salts present in the Carlsbad mineral water (sulphate of soda, bicarbonate and chloride of soda) in the proper proportions, while the dear *Sprudel* salt is only Glauber salt. Probably the cause of this is, that the Carlsbad manufacturers, in order to have fine water-free crystals, of an elegant appearance, collect the crystals of sulphate of soda, first formed in the crystallising mass of salts, and then throw away the mother lye with its carbonate and chloride of sodium. Since I was made acquainted with this fact, some ten years ago, by Professor von Liebermeister, I have followed his example, in the course long pursued by him; I always order Carlsbad salts, mentioning expressly in my prescription the respective amount of its three chief salts. I afterwards satisfied myself that this precaution was necessary also for the artificial salts, procured from manufacturers and from chemists' shops, if I was to order my patients Carlsbad and not Glauber salt. The artificial salt, got from manufacturers and chemists' shops, constantly contains almost Glauber salt only, with carbonate and chloride of sodium, in much smaller quantity than in the real Carlsbad salt. A few years ago I procured a large supply of Carlsbad salts from a firm of good repute. An examination of the beautiful-looking preparation of clear crystals, free of water, showed that it consisted almost entirely of Glauber salt. The watery solution of this preparation did not effervesce on the addition of nitric acid, and on adding some drops of nitrate of silver, there was scarcely any opalescent cloudiness. The manufacturing firm had ordered its salt to be made exactly like the official Carlsbad article, which contains only Glauber salt.

I have repeatedly experienced, especially here in Cologne, where the *Sprudel* salt has many admirers, that patients, for whom I prescribed Carlsbad salts, came to me with the complaint, that they had

[1] E. Harnack, 'Ueber das Karlsbader Sprudelsalz: ein Wort der Aufklärung an das ärztliche Publikum,' *Berlin. klin. Wochenschr.*, 1880, No. 1.

tried the salt, but could not bear it, owing to the purging and griping, &c., which it occasioned. When I made further enquiry, as to the cause of this seeming idiosyncrasy, I found invariably that the natural *Sprudel* salt had been employed. This, being pure Glauber salt, no doubt is not well borne by sensitive stomachs, and causes various inconveniences. I constantly found, that these same patients bore quite well, the mixture of Carlsbad salt ordered by me.

E. Harnack has recently (l.c.), supported by the analysis of the real natural Carlsbad salt, called attention to the defective composition of the *Sprudel* salt. He found in *Sprudel* salt, free of water, sulphate of soda 99·33 per cent., carbonate of soda 0·45, and chloride of sodium 0·07 per cent.

'One is therefore entirely justified in regarding the *Sprudel* salt as very pure Glauber salt, which only differs, apart from the minimal quantity of soda, from ordinary Glauber salt, in costing thirty times as much.'

It is to be hoped that, after this exposure by Harnack, the *Sprudel* salt will gradually disappear from medical practice.

The form in which I have ordered Carlsbad salt for a long time, and which I have introduced into my hospital, is as follows:—

℞	Sulphate of sodium crystallised	50 parts
	Bicarbonate „	20 „
	Chloride „	10 „

At the same time, I do not stick slavishly to this composition. The great advantage, of ordering Carlsbad salt in a prescription, is, that the amount of the individual constituents may be varied, to meet the particular case. The form given above, is recommended at the commencement for weak stomachs, but I often make it even milder, by using the proportion of salts of 2 : 1 : 0·5. Where the object is to increase the peristaltic action much, I order a larger proportion of Glauber salt.

In the same way, as the Carlsbad natural salt can be completely replaced by an artificial one, so can the various mineral waters be replaced by artificial imitations. The use of the salt mixtures, which I have employed for several years, is to be recommended, especially in hospitals and in practice among the poor. I supply, in this way, alkaline, alkaline muriatic, alkaline saline, and various salt waters.

Quincke[1] has very recently shown, how the bitter salt waters also may be completely replaced, and at a very small expense, by imitations. Thus the salt of the Franz-Joseph-Bitterquelle (Ofen) is very closely represented by equal parts of Epsom and of Glauber salts.

[1] 'Ueber Bitterwässer,' *Deutsch. med. Wochenschr.*, 1880, No. 35.

If 50 grammes of each of them are dissolved in 1 litre of water, you get a bitter water containing the same proportion of salts, and as efficient as the natural water. Almost the same mixture answers for the Hunyadi Janos water. Take 30 grammes of sulphate of magnesia, 35 of sulphate of soda, and 1 gramme of chloride of sodium, and dissolve them in a litre of water, and you have a suitable equivalent for it. As easy is it to form the Friedrichshall water. 1 litre of water requires 14 grammes of sulphate of soda, 10 of sulphate of magnesia, 8 of chloride of sodium, and 4 of chloride of magnesia. Quincke calculates that the natural bitter waters cost 4 to 10 times as much, as the salts which they contain.

Besides the mineral waters just mentioned, artificial iron, iodine, and lithium waters are often prescribed. We give the composition of the most useful ones. They are at least equal to the natural waters (as, for instance, the admirable phosphate of iron water, of Struve's). The artificial iodine and lithium waters are far preferable to the natural ones, because they contain larger doses of those substances, and in a really medicinal amount.

The composition of three of Struve's and Ewich's iron waters has been given (p. 405).

Struve's double carbonated iron water contains in the litre 0·5 of carbonate of iron=0·2 metallic iron.

Meyer's carbonated bitter water (made in Struve's establishment) contains in the litre, 2·9 sulphate of soda, 4·3 sulphate of magnesia, 1·7 carbonate of magnesia.

Struve's 'bicarbonated magnesia water' contains in the litre, 16·6 carbonate of magnesia.

Struve's bicarbonated ammonia water contains in the litre, 1·9 carbonate of ammonia.

Richter's tartarate of potass water has 22·9 grammes of tartarate of potass in the litre.

Struve's and Ewich's lithium waters have been given above (p. 369).

Ewich's soda water I. contains in the litre, 1·8 carbonate of soda (equal to 2·5 of the bicarbonate), besides some phosphate of soda. His soda water II. contains more than 5 grammes of phosphate of soda in the litre.

Ewich's iodine lithium water contains, with an amount of carbonate of lithium unknown to me, 0·9 of crystallised iodide of soda in the litre.

Ewich's iodine soda salt water contains 1·3 of crystallised iodid of soda in the litre (see above, p. 381).

The following recipes are recommended for making artificial mineral and other baths :—

1. *Artificial Brine Baths.*—A strong brine bath must contain 2 to 3 per cent. of culinary salt.

In ordering such baths, and the degree of concentration of salts, you must consider the size of the bath, and the amount of water that it contains. From neglecting these obvious considerations, laughable mistakes are often made in prescriptions. The quantity of water for a bath, varies from between 50 litres for a child, and 300 litres, a proper bath for an adult.

For a 1 per cent. brine bath of 50 litres, are required 500 grammes of salt, for 100 litres, 1,000 grammes, for 300 litres, 6 lbs. of salt. For a 2 to 3 per cent. brine bath of 300 litres, 12 to 18 lbs. of salt are needed.

We employ either culinary salt (1 hundredweight costs 10*s.*) or sea salt (1 hundredweight costs 12*s.*), or, what are just as efficacious as these, but much cheaper, the 'denaturirte' culinary salt or the 'cattle salt.'

Siegmund [1] did the medical public, some years ago, the service of calling attention to the Stassfurt bath salt, as an excellent and very cheap substitute for common salt in brine baths. The price of 1 hundredweight of Stassfurt salt (including packing and carriage) is about 16*d.* We compare the composition of this salt with that of the salts of the German Ocean and of the Kreuznach mother lye.

	Stassfurt Salt	Sea Salt	Kreuznach Salt
	Per Cent.	Per Cent.	Per Cent.
Chloride sodium	19·5	77·4	0·8
Chloride potass	24·1	3·3	4·2
Chloride magnesia	38·3	9·1	7·9
Chloride calcium	0·6	—	81·2
Sulphate magnesia	16·6	6·6	—
Sulphate calcium	—	3·6	—
Chloride lithium	—	—	3·5
Chloride strontium	—	—	0·7
Bromide potass	—	—	1·6

It is not of the slightest importance, whether the stimulation of the skin in a brine bath is effected by chloride of soda, chloride of magnesia, or chloride of calcium. The only point of importance, is the degree of concentration of the chlorides. The expensive mother lyes, which are still sent to great distances, can be well dispensed with, and,

[1] 'Ueber künstl. Soolbäder,' *Berlin. klin. Wochenschr.*, 1875, pp. 2 and 3.

for domestic use, perfect substitutes may be made by increasing the amount of the culinary salt. No one in these days will attribute specific action to the chloride of calcium or chloride of magnesia, or even to the iodine and bromine contained in the mother lyes, or any action not to be equally well obtained with culinary salt. If, in spite of all this, the export of mother lyes still flourishes, it is owing, partly, to the simple faith of believing patients, partly to many physicians following the old routine, and being glad to find, that their patients are gratified at the notion of using those expensive preparations, with all their mysterious curative endowments.

The costly natural 'bath salts' are even less wanted than the 'mother lyes.' Culinary salt, cattle salt, or Stassfurt salt are just as good. It is the duty of physicians to protect their patients from the many impositions of this sort.

2. *Sulphur Baths.*—These are made of 100 to 120 grammes of sulphide of calcium, with the addition of 100 grammes of crude hydrochloric acid; and the inhalation of the hydrosulphuric acid is prevented, by spreading cloths across the bath. Or one may order sulphide of potass, 60 to 120 grammes, by itself, or with the addition of 15 to 30 grammes of crude sulphuric acid. Or one may use 60 to 120 grammes of sulphide of sodium, and, when the patient is in his bath, add 30 to 60 grammes of acetic acid.

The Barèges baths, which are used in France, consist of 8 parts of sulphide of calcium, 2 parts of chloride of sodium, 1 part of extract. saponar. and animal gluc. 45 grammes of this mass are used for a bath, which may be well dispensed with.

3. *Iron Baths.*—They, too, might well be given up. The coarse sulphate of iron is employed (60 to 240 grammes for a bath). To represent the carbonic acid of natural iron baths, bicarbonate of soda 60 to 90 grammes, and tartaric acid 10 to 15 grammes, or 22 grammes of phosphoric acid and 50 grammes of carbonate of potass, have been added to the iron.

4. *Lye Baths.*—Crude potashes $\frac{1}{4}$ to 1 lb. for a full bath, or dry caustic potass 30 to 100 grammes, or $\frac{1}{2}$ to 2 lbs. of crystallised soda.

5. *Chloride of Calcium Bath* (not required).—$\frac{1}{2}$ to 1 lb. of chloride of calcium for a full bath.

6. *Mineral Acid Baths* (not wanted).—Made by adding to the bath water 60 to 150 grammes of crude nitric, hydrochloric, or sulphuric acid.

7. *Sublimate Baths* (not wanted).—3 to 15 grammes of corrosive sublimate to the full bath.

8. *Mustard Baths.*—150 to 500 grammes of mustard, or 60 to 100 grammes of spirit of mustard, added to the bath water.

9. *Soap Baths.*—Addition of $\frac{1}{4}$ to 1 lb. of sapo domestic., or green, or aromatic, or of 60 to 100 grammes of spirit. sapon. to the bath water.

10. *Starch Baths* (not at all wanted).—1 to 3 lbs. of starch, boiled in 4 to 6 litres of water; this decoction is added to the bath.

11. *Glue Baths* (not at all wanted).—1 to 2 lbs. of animal glue, dissolved in boiling water and added to the bath.

12. *Malt Baths* (not at all required).—4 to 6 lbs. of barley malt, boiled for half an hour in 4 to 8 litres of water, and added to the bath.

13. *Oak Bark Baths* (not wanted).—A decoction of 1 lb. of oak bark in 4 to 6 litres of water, added to the bath, or, what is simpler, the addition of 20 to 100 grammes of tannic acid. To astringent baths belong those of walnut leaves (a decoction of 1 to 2 lbs.)

14. *Aromatic Baths.*—The cheapest and quite adequate ones are of 'hay flowers,' of which a decoction is made and added to the bath, or you may use chamomile flowers, aromatic spices, calamus root, elder flowers, thyme, marjoram, wormwood, juniper, &c. A decoction of $\frac{1}{2}$ to 2 lbs. is added to the bath. For pine-leaf baths, which may be dispensed with, see above, p. 429.

15. *Iron Peat Baths.*—For their preparation various compounds, which we could do very well without, are employed, as the Franzensbad iron peat salt, &c.

Most of the artificial baths, which have been enumerated, with the exception of the brine baths, belong to the mere lumber room of therapeutic curiosities, which has not yet been closed.

SYNOPSIS

OF THE

EMPIRICAL INDICATIONS OF DIFFERENT DRINKING AND WATER CURES IN INDIVIDUAL DISEASES.

I PROCEED to give a short sketch of the indications at present in use, for different drinking and bathing cures, in various diseases. *Many of these empirical indications cannot stand the test of accurate examination* (on which I shall not enlarge here), *and owe their existence to the general climatic, dietetic, and psychical factors of bath life, rather than to the waters themselves.* I have been sparing in the enumeration of particular baths, as I have already included the names of all important baths, in the preceding tables.

I. DISEASES OF THE RESPIRATORY APPARATUS.

A. CHRONIC CATARRH OF THE RESPIRATORY MUCOUS MEMBRANE.

(LARYNGITIS, TRACHEITIS, BRONCHITIS CHRONICA.)

1. Drinking cures, suitable for this, are—

a. The alkaline acidulous, and the alkaline salt waters (pp. 369, 370). Cures in *Ems*, *Royat*, *Vichy*, *Neuenahr*, *Mont-Dore* (warm springs), *Obersalzbrunn*, *Luhatschowitz*, *Gleichenberg*, *Vals*, *Weilbach* (cold springs), &c.; besides these the domestic use of exported waters of *Bilin*, *Giesshübel*, *Geilnau*, *Fachingen*, *Preblau*, the *Fellathalquelle*, &c., or the alkaline muriatic waters of *Selters*, *Roisdorf*, *Tönnisstein*, &c.

b. The salt waters (pp. 388, 389): *Kissingen*, *Soden*, *Kronthal*, *Mondorf*, *Hall* in Tyrol, *Salzschlirf*, *Pyrmont*, *Wiesbaden*, *Homburg*, &c.

c. In chronic catarrhs of well or over nourished, fat-bellied, robust individuals, the alkaline saline waters of *Carlsbad, Marienbad, Elster, Tarasp, Franzensbad, Rohitsch, Füred, Bertrich*, &c.

d. With anæmia, the simple, and especially the muriatic and alkaline, iron waters (pp. 403, 404), *Elöpatak, Homburg, Elster, Bocklet, Cudowa*; the saline iron springs, *Franzensbad, Rippoldsau*, and the rest of the *Kniebis* baths (Black Forest), &c.

e. The sulphur waters (pp. 416, 417), *Nenndorf, Eilsen, Weilbach, Langenbrücken, Baden* near Vienna, and in Switzerland; the Hungarian and the Pyrenean sulphur baths.

2. Inhalations.

Pulverisation of the alkaline, alkaline muriatic, and salt waters, either by making the waters fall on metallic discs, or by means of a pulveriser, Siegle's or Salès-Girond's apparatus. In most of the places enumerated, there are establishments for this, with inhalation rooms, gas salons, &c. Inhalations with pulverised brine, brine vapour, and brine steam baths, are used in *Rehme* (excellent arrangements), in *Reichenhall*, &c. In other brine baths, use is made of the steam of brine, which is developed by boiling it (*Ischl, Achselmannstein* (Reichenhall), *Münster* am Stein, *Kösen, Kissingen*). Or inhalations are used, of the vapours of gases, which arise from thermal waters (hydrosulphuric acid, carbonic acid, and nitrogen); 'inhalations of well gas' or 'thermal gas,' as they are practised at *Wiesbaden, Warmbrunn, Ems, Pyrmont, Meinberg, Vichy, Landeck, Nenndorf, Eilsen, Langenbrücken, Baden* near Vienna, *Weilbach, Schinznach, Aix la Chapelle*, the *Pyrenean* baths, at *Lippspringe, Inselbad* near Paderborn, and *Contrexéville*.

It is at the least very doubtful, whether the gases, inhaled under such circumstances, are of any value. The working agent in all these inhalations, is the great amount of moisture in the inhaled air, the steam and vapour, with the addition of a little salt at brine baths, and of a little soda at alkaline baths, as *Ems, Vichy*, &c.

Remaining in the neighbourhood of the graduating works is also recommended (p. 387).

3. Milk and whey cures in the mountains: *Reichenhall*,

Aussee, *Ischl*, *Gmunden*, *Gleichenberg*, *Gries*, *Engelberg*, *Gais*, *Interlaken*, *Kreuth*, *Badenweiler*, *Liebenstein*, *Friedrichsroda*, &c.

4. Climatic cures. Mountain air, sea air, elevated health stations, winter health stations (compare 'Climatotherapy').

5. Baths in combination with sweating procedures; vapour baths, sweating cures; particular hydropathic processes, shower baths, &c. (see 'Hydrotherapy').

B. Chronic Pharyngitis.

The following are employed for drinking cures:—

1. The naturally warm or artificially heated alkaline, alkaline muriatic, and salt waters, which serve at once for gargles and for inhalations; cures in *Vichy*, *Ems*, *Neuenahr*, *Luhatschowitz*, &c.; the use of waters of *Selters*, *Roisdorf*, *Gleichenberg*, &c.; the waters of *Soden* in the Taunus, *Mondorf*, *Wiesbaden*, &c.

2. The sulphur waters of *Nenndorf*, *Eilsen*, *Weilbach*, *Baden*, near Vienna, &c.

3. The alkaline saline, and the bitter waters, are scarcely expected to act locally, but rather, by the aid of their influence on the conversion of tissue, to correct various accompanying disorders of the digestion, of general plethora, &c. On the same grounds, alkaline, and alkaline saline iron waters, are recommended, if there is much anæmia; or climatic cures, sea baths, cold water cures, are used to improve the state of nutrition. The cold water cure, especially in chronic pharyngeal catarrh of hypochondriacs.

4. Inhalations of pulverised water (of sulphur waters, alkaline waters, brines, &c.) are very popular remedies; so also are inhalations of well vapours, and of well gases, in which cases it is the moist air only, that has any action, except in the case of brine springs and brine vapour (*Rehme*, &c.) In numberless cases, the pharyngeal catarrh does not undergo the slightest improvement, in spite of methodically conducted bath and well cures.

C. Emphysema pulmonum.

The balneotherapeutic conditions of pulmonary emphysema, are completely covered, by what has been said of chronic catarrh of the respiratory organs. The climatic stations of the Alps are amongst the foremost remedies.

D. Chronic Pneumonia, Chronic Pulmonary Tuberculosis.

Remedies to be used are—

1. Climatic cures; summer and winter cures (see 'Climatotherapy').

2. Certain cold water procedures, as cold frictions, douches, &c., which have been adopted, in many sanatoria, for chest complaints, and for phthisis.

3. Milk and whey cures, in mountain resorts mentioned above (p. 435).

4. As regards drinking cures and inhalations, what we have just said about catarrhs of the respiratory organs (p. 445) holds true. We enumerate *Ems*, *Neuenahr*, *Gleichenberg*, *Obersalzbrunn*, *Luhatschowitz*; *Soden*, *Kronthal*, *Kissingen*, *Baden-Baden*, *Homburg*; *Lippspringe*, *Inselbad*, *Weissenburg*; *Cudowa*, *Charlottenbrunn*, *Reinerz*, *Rippoldsau*, *Griesbach*, *Petersthal*, *Flinsberg*; *Weilbach*; the sulphur thermals of the *Pyrenees*; *Reichenhall*, *Ischl*, *Colberg*, *Kösen*, *Rehme*, *Juliushall*, *Nauheim*, *Kreuznach*, &c.

II. DISEASES OF THE HEART.

But few affections of the heart are suited for drinking or bathing cures—only those in which the muscular power of the heart is not too much lowered, when œdema and other signs of heart insufficiency have not yet supervened, and when the general health is good.

1. Climatic cures rank before all others.

2. Drinking cures are of very secondary importance, and only suited to particular cases.

Functional disturbances of the heart, which depend on increased deposit of the epicardial fat, and on fatty degeneration

of the heart, conditions which are almost always local symptoms of general obesity, may be treated with advantage at the proper time, and with cures carefully conducted, at *Marienbad*, *Tarasp*, *Kissingen*, *Homburg*, *Franzensbad*, *Elster*, *Soden*, *Kronthal*, *Kreuznach*, and occasionally at *Karlsbad*.

For the symptoms of venous obstruction in the abdominal organs (venous hyperæmia of the liver, chronic bowel catarrh, with tendency to constipation), the salt drinking waters, the alkaline muriatic acidulous springs, and even the bitter waters, may be employed, if the general condition admits of it. Besides the waters which have been already named—*Gleichenberg*, *Luhatschowitz*, *Rohitsch*, *Füred*, *Saidschütz*, *Sedlitz*, *Püllna*, *Friedrichshall*—the stronger *Ofen* bitter water may be eventually used.

As after cures (*Nachkuren*) after acute endo- or pericarditis, which so often supervenes in acute rheumatism of the joints, besides the employment of the salt and muriatic alkaline waters just mentioned, the saline iron waters, and especially the acidulous iron waters, will be found sometimes to answer—for instance, *Franzensbad*, *Elster*, *Rippoldsau*, *Cudowa*, *Reinerz*, *Flinsberg*, *Pyrmont*, &c. These latter are to be recommended in nervous palpitation, in disturbance of the innervation of the heart, in erethismus of the heart, with an anæmic or chlorotic basis.

3. Bath cures. Cool baths of the indifferent waters, (*Schlangenbad*, *Johannisbad*, *Wildbad*, *Liebenzell*, &c.), or even weak skin-stimulating baths (brine), may, if employed with foresight, be useful in particular cases. In nervous palpitations and nervous irritability of the heart, sea bathing and various cold water processes, judiciously employed, are often borne well, and produce a certain, often only a temporary improvement.

4. Milk cures in the mountains, in some cases whey cures also, in the places mentioned above (p. 435).

III. DISEASES OF THE NERVES.

A. General Nervousness.

(The so called Nervous Temperament, Fatigue Neurosis, Irritable Weakness, Spinal Irritation, 'Neurasthenia.')

1. Climatic cures—sea coast air—residence in the country—residence in the mountains—travelling (see 'Climatotherapy').

2. Various hydriatic or cold water cure procedures appropriate to the particular case (see 'Hydrotherapy').

3. Drinking and bathing cures of various sorts: sea baths, brine baths (*Nauheim*, *Rehme*, *Ischl*, *Reichenhall*, *Kissingen*, *Kreuznach*, *Wiesbaden*, &c.) If anæmia is a prominent symptom, the steel baths rich in carbonic acid: *Schwalbach*, *St. Moritz*, *Pyrmont*, *Bocklet*, *Steben*, *Franzensbad*, *Elster*, and many others. Iron peat baths at *Franzensbad*, *Marienbad*, &c. For individual cases, the indifferent thermals are suitable as 'soothing baths:' *Gastein*, *Wildbad*, *Ragatz* and *Pfäffers*, *Warmbrunn*, *Teplitz*, &c.

B. Hysteria and Hypochondria.

The treatment ought to be directed to the cause, to the etiology of the particular case, and also with reference to the constitution of the patient, which must always determine the general as well as the special balneotherapeutic treatment.

We have to consider:

1. Climatic cures (see under A). 2. Cold water cures, sea baths, river baths, &c. 3. Different bathing and drinking cures, according to the locality of the particular case, brine baths, warm salt baths, steel baths: in hypochondria with chronic catarrh of the bowels, or with general obesity and over-nutrition, the alkaline Glauber salt and bitter waters. Cures in *Marienbad*, *Tarasp*, *Karlsbad*, *Elster* (salt well), *Kissingen*; also cures in *Homburg*, *Wiesbaden*, *Kronthal*, *Mondorf*, *Neuhaus*, *Soden*, &c.

C. Neuralgias.

(Sciatica, Lumbago, Intercostal Neuralgia, Migraine, Hemicrania, etc.)

1. In sciatica and lumbago, baths of the indifferent or weak salt thermals, and of the sulphur thermals: *Teplitz*, *Wiesbaden*, *Gastein*, *Baden-Baden*, *Ragatz*, *Warmbrunn*, *Wildbad*, *Aix-la-Chapelle*, *Burtscheid*, &c. Peat and sulphur slime baths at *Franzensbad*, *Marienbad*, *Elster*, *Nenndorf*, *Eilsen*, &c.; vapour baths, sand baths, some cold water processes.

2. In migraine, climatic cures, residence in the mountains, sea air, sea baths, cold water treatment.

3. Various drinking and bathing cures. The indication for them depends on the circumstances which have occasioned, or which accompany the neuralgia: that is, according to the presence of other pathological conditions, or disorders of nutrition. A high degree of anæmia indicates the use of iron and brine baths, &c. Milk and whey cures, &c. If there be general obesity, with affection of stomach and bowels, arthritic condition, or uterine and ovarian disorders, to cause it—the drinking and bathing cures appropriate for such affections.

D. Different Paralyses.

1. Fresh apoplectic paralysis (hemiplegia), resulting from cerebral hæmorrhage, is not a subject for drinking or bathing cures. The same applies to those cerebral hæmorrhages and embolisms, which result from high degrees of atheroma, from hypertrophy of the heart, chronic valvular deficiency, granular atrophy of the kidneys. Balneotherapeutic treatment has also constantly to bear in mind the danger of relapses of hæmorrhage. Therefore hot baths, vapour baths, and also cold baths, as well as the free use of warm mineral waters, &c., must be avoided. For stationary not very recent apoplectic paralysis, we have in the first rank the lukewarm indifferent thermals (*Badenweiler*, *Landeck*, *Liebenzell*, *Johannisbad*, *Wildbad*, *Ragatz*, *Schlangenbad*, *Bertrich*, *Gastein*, &c.), the weak salt thermals (*Wiesbaden*, *Baden-Baden*), for some cases

also the thermal brine baths (*Rehme*, *Nauheim*), and the sulphur thermals. We may mention experiments with local baths, local douches, and peat and sand baths, which are applied to the paralysed extremities, local carbonic acid gas baths, Scottish douches, &c.

Drinking cures may operate favourably by improving the general state of nutrition, or by removing pathological disorders which affect the nutrition injuriously—iron waters in anæmia, alkaline ones in arthritis. Careful cures at *Marienbad*, *Tarasp*, *Homburg*, *Soden*, &c., in hypernutritive 'plethoric' obesity. Such cures, which meet certain indications, may be ot some advantage as prophylactic, and diminishing the chance of relapses. In this last point of view, climatic changes and milk and whey cures may be recommended.

2. Paralyses after large losses of blood, after acute febrile, especially infectious diseases, after typhus or acute exanthemata, after diphtheria, offer a favourable prognosis. They improve and are cured, as the general health mends, equally well whether drinking or bathing cures are employed or not. The cure may, however, be supported by the use of different baths, as the indifferent, the salt, the iron, the sulphur baths, by aromatic baths, and also by climatic cures, milk cures, &c.

3. As to the balneotherapeutic treatment of hysteric paralysis, what we have already said of hysteria in general applies. The various procedures of the water cure are often of marked benefit in such cases.

4. Reflex paralyses, which accompany chronic diseases of the sexual organs of females, and chronic bladder affections (urinparaplegia), and which often depend on ascending neuritis, are very seldom influenced at all by baths. The absorption of neuritic exudations may perhaps be favoured by baths. Therefore indifferent, sulphur, carbonated iron baths, as well as salt thermals and brines, are recommended. As regards these affections, all these baths stand much alike.

5. The same must be said of the balneological treatment of peripheral rheumatic, and traumatic paralysis depending on inflammation (neuritis). More may perhaps be expected here from local baths and applications.

6. Toxic paralysis (lead palsy). The indication for the use of

certain drinking and bathing cures is the same as for chronic metallic poisoning.

E. Affections of the Spinal Cord and its Sheaths.

Chronic myelitis, with its terminations in sclerosis, or grey atrophy, interrupted myelitis (in patches), continuous fascicular or systemic degeneration, grey degeneration of the posterior columns (tabes), the descending degeneration of the pyramidal tracts, commencing from certain centres of disease in the cerebrum, or from a circumscribed myelitis, transverse or compression myelitis, central sclerosis, acute, subacute, and chronic poliomyelitis (atrophic spinal paralysis), and essential paralysis of children ; these, and other affections of the spinal cord, come balneotherapeutically under the same category.

What is destroyed and has degenerated, cannot, of course, be restored by baths. Products of inflammation, however, exudations and infiltrations, can be absorbed, and the absorption may perhaps be assisted by baths, and this may happen either directly or indirectly, i.e. by the influence of the baths on the general condition. All active weakening processes must be avoided in the diseases just mentioned, such as hot baths, vapour baths, violent douches, and cold baths. Lowering drinking cures are also contra-indicated.

On the other hand, lukewarm baths are very properly recommended in some of these affections, especially the indifferent thermals (*Schlangenbad*, *Wildbad*, *Johannisbad*, *Gastein*, *Liebenzell*, &c.), and also salt baths, and the gaseous brine thermals (*Nauheim*, *Rehme*), further sulphur thermals, and warm sea baths. As the chief object of all these baths is to improve the general health, climatic cures, residence in the mountains, or at the seaside, milk cures, &c., produce similar effects.

Drinking cures with steel waters, with salt, alkaline Glauber salt bitter waters, may relieve certain accompanying symptoms, such as anæmia, hypernutrition and obesity, chronic stomach and bowel catarrh, habitual constipation, &c.

In transverse myelitis, brought on by spondylarthrocace, or by deforming or gouty arthritis of the vertebræ, the absorp-

tion of inflammatory exudations may be favoured by the use of baths (indifferent thermals, brine baths, thermal brine baths, &c.), and the compression of the spinal cord may thus be lessened, and some opposition offered to the extension of the inflammation, from the bodies of the diseased vertebræ and vertebral joints, to the spinal cord.

I have observed most striking success follow the treatment at *Wildbad*, of a bad case of transverse myelitis with spondylitis.

In like manner, the exudations of spinal meningitis, as they occur in spondylitis, in fractures and wounds of the vertebral column, in tumours of it or the spinal cord, or after severe exposure to cold, may be favourably influenced by warm baths. The possibility of exciting the process of absorption by these means cannot be denied, and is supported by experience.

Bath and well cures are employed also in various other affections of the nervous system, as in chorea, paralysis agitans, in functional cramps (writers' or weavers' cramps), in progressive muscular atrophy, in paralysis of individual muscles and nerves, in congestion of the brain, in attacks of giddiness, &c. In all these cases, the selection of the bath or well cure should be influenced, often less by the special nerve affection, than by the presence of certain disorders of nutrition (anæmia, plethora), or by the pathological disturbances which accompany the nerve affections.

In progressive muscular atrophy, hot baths are properly avoided. It is known that they increase the conversion of tissue, without being able to guarantee a sufficient power of resistance against it. Lukewarm baths of the indifferent thermals, brine thermals rich in gas (*Rehme* and *Nauheim*), local baths, douches, &c., are appropriate here. In chorea, it is a question of indifferent thermals, of iron, brine, sea baths, milk cures, climatic cures, &c., according to the presence of anæmia, chlorosis, scrofula, or rheumatic affections.

IV. DISEASES OF THE ORGANS OF DIGESTION.

A. Chronic Stomach Catarrh.

(Chronic Dyspepsia, Chronic Ulcer of the Stomach.)

The balneotherapeutic treatment of chronic stomach catarrh varies according to its etiology and symptoms.

With reference to the etiology we have to consider the idiopathic stomach catarrh of drunkards, of great eaters, of gluttons, of people of sedentary habits, of irregular ways in taking nourishment; then that of anæmics and of convalescents; then the stomach catarrh in consequence of obstruction of the portal system, or of cirrhosis of the liver, &c., and the stomach catarrh which attends ulcers of that organ.

As regards symptoms, we have to draw a distinction between cases in which the stomach catarrh sets in with disturbed secretion of the gastric juice, either diminished or increased; then again, the cases in which great atony of the muscles of the stomach, muscular insufficiency, or relaxation of it, exist, with or without distinct dilatation; further, cases in which there is narrowing of the pylorus, and where there is a tendency to hæmorrhage from recurring ulcers. Various wells have to be considered.

1. The alkaline acidulous waters, which are suitable for the abnormal generation of acid in pyrosis, in sour eructations, when free hydrochloric acid is found to be present in the empty stomach; and which, by their carbonic acid, aid peristaltic action. To these belong the exported waters of *Fachingen*, *Geilnau*, *Giesshübel*, the *Fellathal* waters, also *Bilin*, *Preblau*, *Salzbrunn*; drinking cures in *Vichy*, *Neuenahr*.

2. The alkaline muriatic acidulous, and the alkaline saline waters, unite the peristaltic action-exciting power of culinary and of Glauber salt, with the acid-destroying and mucus-loosening power of the alkalies. Their success is therefore proclaimed, especially in abnormal production of mucus, in atony and torpor

of the muscular coats of the stomach, in diminished reflex excitability of the mucous membranes, in delay of the contents of the stomach in it, in the presence of elements of fermentation, the removal of which is assisted by these. The most important representatives of this group are *Selters*, *Roisdorf*, *Gleichenberg*, *Obersalzbrunn*, *Luhatschowitz*, *Ems*, *Tönnisstein*; further, among the alkaline saline waters, *Karlsbad*, *Marienbad*, *Franzensbad*, *Elster*, *Tarasp*, *Rohitsch*, *Füred*, *Bertrich*, &c.

3. The salt drinking wells: their indication is the same as that of the alkaline muriatic and alkaline saline waters. We name *Kissingen*, *Homburg*, *Kronthal*, *Mondorf*, *Nauheim*, *Neuhaus*, *Pyrmont* (salt well), *Soden*, *Wiesbaden*, *Baden-Baden*, &c.

In many cases of chronic stomach catarrh, in people of sedentary habits, in hypochondriacs, in anæmic persons, or those who are exhausted by over-work, in what is called nervous dyspepsia, more benefit is often got from sea bathing, from cold baths, and other hydrotherapeutic processes, from climatic cures in the mountains or at the seaside, from travelling in the mountains, from milk cures, than from drinking cures.

The use of alkaline, saline, or muriatic iron acidulous waters (besides the springs just mentioned and climatic cures) is often advantageous in dyspepsia connected with chlorosis or anæmia. Such waters are those of *Franzensbad*, *Elster*, *Rippoldsau*, *Cudowa*, *Bartfeld*, *Elöpatak*, *Pyrmont*, *Schwalbach*, *Driburg*, &c.

B. Chronic Intestinal Catarrh.

(Habitual Constipation, Chronic Diarrhœa, etc.)

Chronic intestinal catarrh is often united with chronic stomach catarrh, and the directions given above are good for both. But their etiology is different. The well cure is selected partly with reference to this, but still more to the symptoms. Sometimes the chronic bowel catarrh is the consequence of an acute attack of it. Sometimes it comes on from the beginning, in a slow creeping way (the catarrh of sedentary life and of improper nourishment); or it is occasioned by stagnation in the portal system (cirrhosis, chronic heart and lung

affections), or it accompanies anæmic chlorosis, certain disorders of nutrition, like obesity, or protracted convalescence, &c.

In most cases chronic bowel catarrh is united with atony of the bowels, and with habitual constipation. Hæmorrhoidal troubles are a frequent accompaniment of chronic catarrh, and fortunately the balneotherapeutic treatment of both is the same.

In these cases, the alkaline acidulous and alkaline muriatic waters, already mentioned under A, are to be had recourse to. But the following ones deserve a more special recommendation:

1. The alkaline saline or Glauber salt waters, *Karlsbad*, *Marienbad*, *Tarasp*; the salt wells at *Elster*, *Franzensbad*, &c.

2. The use of bitter waters—*Friedrichshall*, *Ofen*, *Püllna*, *Saidschütz*, *Sedlitz*, &c.

3. The salt wells of *Kissingen*, *Soden*, *Kronthal*, *Homburg*, *Nauheim*, *Wiesbaden*, &c.

On the whole, as also in the case of stomach catarrh, the use of naturally warm or artificially heated waters is best; this especially in the case of lean, anæmic, weakly, oldish individuals; the colder waters may be preferred for full-blooded, robust, stout people.

In a good many cases of chronic intestinal catarrh with constipation, baths are found useful, with or without a drinking cure, especially the colder forms of bath: sea baths, river baths, cold water cures, also climatic cures, pedestrian tours in the mountains, milk, whey, and grape cures. The last answers best, in the catarrh of hæmorrhoidal patients combined with constipation, in persons of sedentary habits, and in hypochondriacs.

The chronic bowel catarrh, united with habitual diarrhœa, calls for the use of the alkaline muriatic, and especially of the warm alkaline saline wells of *Carlsbad*, while the bitter waters are to be avoided. Climatic cures and sea baths, or cold water cures employed with discretion, are sometimes of advantage.

The alkaline or earthy iron waters, are also often recommended: *Bocklet*, *Driburg*, *Pyrmont*, *Schwalbach*, *Liebwerda*, *Reinerz*, *Imnau*, *Rippoldsau*, *Altwasser*, *Charlottenbrunn*, &c.

C. Diseases of the Liver and Gall Ducts.

(Icterus Catarrhalis, Cholelithiasis, Cirrhosis Hepatis, Chronic Inaction of the Liver.)

The following waters are all suited for these affections:

1. The alkaline waters, especially drunk warm, as *Vichy*, *Lipik*, *Neuenahr*, and also *Obersalzbrunn*, *Bilin*, *Giesshübel*, &c.

2. The alkaline muriatic wells of *Ems*, *Luhatschowitz*, *Gleichenberg*, *Roisdorf*, &c.

3. Especially the alkaline saline waters of *Karlsbad*, *Bertrich*, *Marienbad*, *Elster*, *Franzensbad*, *Rohitsch*, &c. Among these, *Carlsbad* has obtained a world-wide and a deserved reputation.

4. The salt drinking wells of *Wiesbaden*, *Homburg*, *Soden*, *Kronthal*, &c.

5. For particular cases, with obstinate constipation, the bitter waters.

The treatment for fatty liver, is the same as that for general obesity.

V. DISEASES OF THE URINARY ORGANS.

A. Catarrh of the Bladder, of the Pelvis of the Kidney.

Here are to be considered:

1. The copious drinking of alkaline acidulous waters; those of *Fachingen*, *Bilin*, *Giesshübel*, the *Apollinarisbrunnen*; drinking cures at *Vichy*, *Neuenahr*, *Obersalzbrunn*, &c.

2. The alkaline muriatic waters of *Ems*, *Luhatschowitz*, *Selters*, &c.

3. The highly carbonated earthy lime waters of *Wildungen*, and *Driburg* (Hersterquelle).

If there be present at the same time disorders of digestion, or chronic bowel catarrh with habitual constipation, the alkaline saline waters (*Karlsbad*, *Marienbad*, *Bertrich*, &c.), or the salt

wells (*Kissingen*, and the saline wells of *Elster* and *Franzensbad*) may be of service.

Lukewarm baths are often beneficial.

B. Urinary Calculi (Bladder, Kidney).

For all such cases, whatever the nature of the stone may be, the copious drinking of warm water is suited.

In uric acid calculi, especially the alkaline and alkaline saline waters of *Vichy*, *Karlsbad*, *Neuenahr*, *Lipik*, *Bilin*, *Fachingen*, *Apollinarisbrunnen*, &c.

In phosphate of lime stones, the abundant use of highly carbonated waters, especially of the simple acidulous ones (see pp. 351, 352).

In oxalate stones, the use of strongly carbonated alkaline, and of the simple acidulous waters.

Warm baths assist the cure.

In lithiasis of the urinary passages, the earthy highly carbonated waters of *Wildungen* and *Driburg* (Hersterquelle), besides those that have been already mentioned, enjoy a special reputation. The catarrh of the urinary passages attending lithiasis, indicates the waters enumerated under A.

C. Chronic Bright's Disease.

This is a subject for balneotherapeutic treatment, only in rare cases and in some forms. Usually, particular mineral waters which are used for certain symptoms (disorders of digestion, constipation, anæmia) are employed. Besides these, the following deserve consideration :

1. The indifferent thermals, both in the form of bathing and of drinking, *Wildbad*, *Teplitz*, *Schlangenbad*, *Gastein*, &c.; further, the sulphur and calcareous thermals.

2. The use of simple and alkaline acidulous waters, the alkaline saline wells, the bitter waters, the carbonated iron wells, the weak salt waters.

3. Milk cures at climatic stations; further, hot baths, vapour baths, and sand baths, carefully employed.

D. Appendix.—Enlargements of the Prostate.

1. The indifferent thermals, the brine baths, salt thermals, sulphur thermals, peat and slime baths.

2. Drinking cures in *Kissingen*, *Homburg*, *Wiesbaden*, *Ems*, *Vichy*, *Baden-Baden*, *Soden*, *Kronthal*, *Nauheim*, *Mondorf*, *Karlsbad*, *Marienbad*, *Bertrich*, *Franzensbad*, &c.

The springs, enumerated under A, for the accompanying bladder catarrh.

VI. DISEASES OF THE FEMALE SEXUAL ORGANS.

(Chronic Metritis, Peri- and Parametritis, Oophoritis, Pelveo-Peritonitis, Chronic Catarrh of the Uterine and Vaginal Mucous Membranes.)

1. Brine baths and mother lye baths (full baths, sitz baths, vaginal injections, fomentations, &c.): *Kreuznach*, *Elmen*, *Dürkheim*, *Krankenheil*, *Salzhausen*, *Juliushall*, *Kissingen*, *Rehme*, *Nauheim*, *Achselmanstein*, *Reichenhall*, *Kösen*, &c.

2. The indifferent thermals: *Schlangenbad*, *Gastein*, *Wildbad*, *Landeck*, &c. The sulphur baths have also the same pretensions, and the Pyrenean ones (St. Sauveur), known as 'ladies' baths,' as well as the weak salt thermals of *Wiesbaden*, *Baden-Baden*, &c.

3. The strongly carbonated iron waters: *Schwalbach*, *Elster*, *Pyrmont*, *Steben*, *St. Moritz*, *Driburg*, *Bocklet*, *Cudowa*, *Brückenau*, *Franzensbad*, *Griesbach*, *Imnau*, *Königswart*, *Reinerz*, &c.

4. The peat and slime baths: *Marienbad*, *Franzensbad*, *Elster*, *Pyrmont*, *Meinberg*, *Nenndorf*, *Eilsen*, &c.

Various wells are suitable for drinking cures in connection with bathing; their selection is determined in the particular case by the constitution, the strength, the state of nutrition of the patient (plethora, anæmia, &c.), or by the prominent symptoms (constipation, disturbance of digestion). They are—

1. Salt drinking springs: *Kreuznach*, *Elmen*, *Dürkheim*, *Hall* in Austria, *Heilbrunn*, *Krankenheil*, *Kissingen*, *Homburg*, *Wiesbaden*, *Baden-Baden*, *Nauheim*, *Soden*.

2. The iron waters, particularly when there is pronounced chlorosis and anæmia: *Schwalbach*, *Pyrmont*, *Driburg*, *Meinberg*, *Steben*, *Brückenau*, *Bocklet*, *Imnau*, *St. Moritz*, *Franzensbad*, *Elster*, *Bartfeld*, &c.

3. The alkaline muriatic wells (*Ems*, *Luhatschowitz*, &c.), and especially the alkaline saline ones (*Karlsbad*, *Marienbad*, *Tarasp*, &c.), are adapted for particular cases which are accompanied by disorder of digestion, habitual obstipation, and obesity; occasionally also the bitter waters. There is a whole crowd of patients, who have been made hysterical and nervous by excessive local treatment, who are weakened, physically and mentally, and whose numbers have increased rapidly, with the advance of gynæcology in certain directions. For them we recommend residence in climatic stations, in the mountains, or by the seaside, further milk cures, and in particular cases sea bathing. By such cures it is often possible to rescue the patient from the dread of a dangerous uterine affection, inspired by gynæcologists, and to make her well and enjoy life again. The balneotherapy of chronic dysmenorrhœa and of amenorrhœa, ought to be directed against their cause, and is either the same as what has just been indicated, or makes the use of iron baths necessary (with anæmia and chlorosis).

VII. ANÆMIC CONDITIONS.

(Chlorosis, Various Forms of Anæmia, Protracted Convalescence.)

There are, of course, no bathing or drinking cures that act specifically on these complaints. This is true even of the steel waters, whose reputation for acting specifically as 'blood makers,' has no real foundation. We observe that anæmias and chloroses improve, under the use of very diverse drinking and bathing cures, as well as under climatic cures. We have to mention—

1. Climatic cures. Residence in the country, in connection

with milk cures, Alpine air, sea air, along with the use of warm sea baths. Cold sea bathing and cold water cures are indicated only in rare cases; they are, however, borne in uncomplicated anæmia, and where the constitution is otherwise strong; but even in such cases, if cold water cures are to be used, they should be commenced very mildly. Wintering in southern climates (see 'Climatotherapy').

2. The internal and external use of iron waters. They are almost all, as everyone knows, distinguished by containing a large supply of carbonic acid. I may name *Schwalbach*, *Pyrmont*, *Steben*, *Driburg*, *Reinerz*, *Liebenstein*, *Königswart*, *Elster*, *Cudowa*, *Brückenau*, *Bocklet*, the Kniebis baths lying in the mountains, *Rippoldsau*, *Antogast*, *Griesbach*, *Petersthal*, also *St. Moritz*, &c. In cases of anæmia which commence with constipation and with chronic catarrhs of the stomach and intestines, the alkaline saline and the salt iron waters are to be recommended: *Franzensbad*, *Elster*, *Rippoldsau*, and the Kniebis baths, *Cudowa*, the *Homburg* (Stahlquelle), *Hofgeismar* (Badequelle), &c.

3. Brine baths, especially the thermal ones rich in carbonic acid, of *Rehme* and *Nauheim*. Among the brine baths those lying in the Alps, or among the mountains, deserve the preference, as *Ischl*, *Aussee*, *Reichenhall*, *Soden* in the Taunus, *Hall* in Tyrol, *Gmunden*, *Kreuth*, *Bex*, *Juliushall*, or *Colberg*, lying on the shores of the Baltic.

The balneotherapeutic treatment of different forms of anæmia must take into account their causes. Anæmia which is in connection with chronic ulcer of the stomach, with chronic catarrh of stomach and bowels, with chronic diseases of the female sexual organs (infarction, &c.), with chronic Bright's disease, with commencing tuberculosis, scrofula, hæmorrhoidal bleedings, defects of the heart, chronic intermittent, with amyloid degeneration, caries of the bones, leucæmia, pseudo-leucæmia, &c.—such anæmia, is either inaccessible to bathing and drinking cures, or requires the selection of waters that will attack the source of the disease. There can be no specific action, of iron peat baths in chlorosis and anæmia; nevertheless they may, in cases of anæmia induced by chronic metritis and parametritis, influence the causal disease favourably.

VIII. GENERAL OBESITY.

(POLYSARCIA, SO CALLED PLETHORA.)

The warm or cold alkaline saline wells are recommended: the first in weakened constitutions, in obesity conjoined with anæmia; the last, the cold Glauber salt wells, in the form of polysarcia which is conjoined with full-bloodedness. Cures in *Marienbad*, *Tarasp*, *Franzensbad*, *Elster* (salt well), *Rohitsch*, *Karlsbad*, or also the bitter water cures, in conjunction with suitable diet and mode of life. The salt drinking cures of *Kissingen*, *Soden*, *Homburg*, *Neuhaus*, &c., also answer in many cases.

Climatic cures, in conjunction with suitable diet and way of living (pedestrian tours in the mountains), suit some cases.

IX. SCROFULA.

We have—

1. Climatic cures, especially in the mountains. Residence in the country, in conjunction with milk cures; residence by the seaside; wintering in the South, or in elevated stations (see 'Climatotherapy').

2. Sea baths warmed, for weakly, poor-blooded, and very young children; cold, for those who are of better constitution, and for the torpid (pasty) form of scrofula.

3. Brine baths. The different brine baths are, as regards their value in scrofula, all on one footing. If the brine wells, which contain iodine and bromine, boast of greater and of specific success, it is a mere exaggeration. The imaginary superiority which is ascribed to the amount of iodine and bromine present, is purely illusory.

The selection of the brine bath, as should be the case in all drinking and bathing cures, depends on various, sometimes quite external, circumstances: for instance, the distance from the home of the patient, the facilities of travelling, the expense, the promise of comfort and of amusement, &c. Among the brine baths, those are to be preferred which lie amongst the mountains and the Alps, on account of their climatic advantages, and the facilities for getting excellent milk, &c.

The baths of mother lyes, which are so bepraised in the treatment of scrofula, do not differ in the least from simple concentrated brines.

In many of the brine baths, the employment of salt drinking waters is conjoined with the use of the baths. This is the case at *Kreuznach*, *Elmen*, *Dürkheim*, *Salzschlirf*, *Münster* a. Stein, *Goczalkowitz*, *Mondorf*, *Heilbronn*, *Tölz*, *Sulza*, *Passug*, *Kissingen*, *Soden* in the Taunus, and *Soden* near Aschaffenburg, *Nauheim*, *Salzbrunn*, &c.

In the baths, so much visited by scrofulous patients, of *Ischl*, *Aussee*, *Gmunden*, *Hall* in Tirol, *Arnstadt* in Thuringia, *Reichenhall*, *Achselmannstein*, *Kreuth*, *Bex*, *Juliushall*, *Colberg*, *Kösen*, baths are used almost exclusively.

The thermal brines of *Rehme*, *Nauheim*, *Soden*, are no less to be recommended in scrofula, than the preceding baths.

4. Iron baths, in which the large supply of carbonic acid has the same stimulating effect on the skin, as the salt of the brine bath. We should select such as lie in the mountains, *St. Moritz*, *Flinsberg*, *Driburg*, *Pyrmont*, the *Kniebis* baths. The iron waters are also used internally in most cases. Iron peat baths may now and then be serviceable in some scrofulous affections (periostitis, caries), &c.

5. The 'wild' baths which lie in the mountains, are excellent places for many scrofulous patients, especially when an irritable skin with tendency to eczema forbids the use of salt baths. The position of almost all the indifferent thermals in Alpine districts, makes these climatic resorts of the first value. The sulphur, the calcareous, and the weak salt thermals are as useful as the indifferent ones, whenever they are equal to them in climatic respects.

The use of alkaline muriatic waters, is recommended in catarrhs of the respiratory tract connected with some forms of scrofula.

The internal exhibition of the calcareous thermal waters in struma, rests only on unproved theoretical considerations.

Peat and slime baths, sulphur baths, &c., are recommended in certain local scrofulous affections, hypertrophy of glands, chronic exanthemata, caries, &c. Many speak favourably of whey cures, herb baths, and cold water cures in scrofula.

X. CHRONIC RHEUMATISM.

(RHEUMATIC AFFECTIONS OF THE JOINTS, MUSCLES, ETC.)

As warmth is the chief agent in the balneotherapeutic treatment of rheumatism, the most different warm and hot baths, whether they contain salts and gas or not, all lay claim to being beneficial in rheumatism. They are—

1. The simple warm and hot baths, vapour baths (Russian vapour baths), sweating cures, sand baths, peat and slime baths, &c.

2. The indifferent and the sulphur thermals, the warm and hot brines, salt and earthy thermals. Cures in *Teplitz*, *Warmbrunn*, *Plombières*, *Gastein*, *Pfäffers*, *Wildbad*, *Schlangenbad*, *Landeck*, *Leuk*, &c.; in *Aix-la-Chapelle*, *Burtscheid*, *Baden* near Vienna, *Baden* in Switzerland, *Mehadia*, &c.; cures in the brine thermals of *Rehme*, and *Nauheim*; cures in *Wiesbaden*, *Baden-Baden*, &c.

3. Local baths, packings, peat and sand cataplasms, hot moist fomentations, warm douches and frictions: further, the application of electricity, which is practised in many baths, and, last not least, *massage* (shampooing, kneading).

Drinking cures play only a subordinate part. Their object is, either to keep up the perspiration produced by hot baths (internal use of the indifferent thermals, of sulphur waters, &c.) or, when taken freely, to effect a general washing out of the system. Many believe that they can influence the change of tissue, and produce the absorption of exudations in the joints, muscles, fasciæ, sinews, &c., by the use of alkaline, alkaline saline and muriatic, and of salt waters. Or the drinking cures are intended to improve the nutrition, and to influence favourably certain pathological accompaniments of chronic rheumatism (anæmia, nervous irritability, &c.)

Cold water processes, cold baths, friction, sea and river baths, and climatic cures, if used carefully, serve to 'harden' the skin when the rheumatism has been got over.

XI. GOUT.

(Lithic Acid Diathesis.)

What we have just said of the use of baths in rheumatism, applies equally to gout and the affections depending on it, of the joints (arthritis, ankylosis), of the muscles (contractions and paralyses), of the sinews, and of the fasciæ. The indifferent baths enjoy the greatest reputation. But other baths, warm, or it may be hot, have the same title to favour, such as the simple warm and hot baths, the vapour baths, which of course only answer for particular cases, the sulphur thermals, the weak salt thermals (*Wiesbaden*, *Baden-Baden*), the brine thermals, the peat and slime baths, the calcareous thermals (*Leuk*), the carbonated iron baths.

Water has the most important share in drinking cures:

1. The copious consumption of water (washing-out cures), drinking cures, of the indifferent thermals, in conjunction with baths.

2. The alkaline, the alkaline saline, the alkaline muriatic waters. The warm sources of *Vichy*, *Lipik*, *Neuenahr*, *Ems*, *Royat*; the use of the cold alkaline waters of *Bilin*, *Fachingen*, *Preblau*, *Obersalzbrunn*, *Gleichenberg*, *Giesshübel*, *Luhatschowitz*, *Tönnisstein*, *Passug*, *Vals*. The alkaline saline waters commend themselves especially in gout setting in with general over-nutrition (plethora, obesity): as *Marienbad*, *Tarasp*, *Rohitsch*, *Elster*, *Franzensbad* (salt well), *Füred*; or the warm waters of *Karlsbad*, *Bertrich*. The weak salt water wells of *Homburg*, *Wiesbaden*, *Baden-Baden*, *Kissingen*, *Soden* a. T., &c., are equally recommended.

Many attach undeserved weight to the presence of lithium in the waters of *Salzschlirf*, *Elster*, *Baden-Baden*, *Dürkheim*, *Bilin*; but the artificial lithium waters of Struve, or of Ewich, contain a great deal more of that substance, than any of those waters do (compare what was said above, p. 368). The bitter waters are successful in some cases, where there is obstinate constipation, and obstruction of the abdominal venous system. The alkaline saline iron waters, especially those of *Franzens-*

bad, *Elster*, *Bartfeld*, are suitable for anæmic weakly patients. Climatic cures are often useful in raising the standard of nutrition and of strength, especially in slighter cases and as an after-cure. Cold water cures properly come last. Diet and mode of life (exercise in the open air, &c.) play a very important part, in the balneotherapeutic as well as in the ordinary treatment of gout.

XII. DIABETES.

The success obtained by the use of various drinking cures in diabetes, which in the majority of cases does not go beyond an improvement of the general state of nutrition, and of the strength of the patient, depends on a systematic regulation of the diet and mode of life of the patient, and on the climatic and mental factors of bath life. Certain forms of diabetes, which yield to the exclusion of amylaceous articles of diet, are, of course, cured at baths under similar conditions of treatment. If from this we conclude that the spring has anti-diabetic virtues, this is one of the illusory conclusions which are so wonderfully common respecting the success of bath cures.

Neither copious water drinking, nor the baths and drinking use of waters of various compositions, are capable of influencing favourably the cause of diabetes, the excretion of sugar. The drinking of alkaline waters, which still figures as a cure of diabetes in newspaper announcements and in popular bath journals, can only operate favourably in diabetes, in so far as it diminishes or removes the pathological conditions which accompany diabetes (constipation, stomach catarrh, &c.) In a similar way, warm baths are often useful in a tendency to eczema, furunculosis, &c. The great reputation which *Vichy*, *Karlsbad*, and *Neuenahr* possess in the treatment of excessive excretion of sugar in the urine, must not make us forget what has been said above about diabetes (p. 363).

Climatic cures in connection with suitable diet, and the use of warm baths (indifferent thermals in the mountains), are often successful in cases of diabetes. I have seen excellent results follow from systematically pursued milk cures along with anti-diabetic diet.

XIII. CONSTITUTIONAL SYPHILIS.

No one will pretend to say that certain baths and drinking cures, especially those of the so-highly-praised sulphur baths, are able alone to cure constitutional syphilis. There can be no idea of any specific action of such waters. This is best shown by the extraordinarily free use which is made of mercurials and of iodide of potass at some renowned baths, as Aix-la-Chapelle and others, and to which those places owe mainly their fame in the cure of syphilis.

Warm and hot baths, irrespective of what salt or gases they contain, are useful in many cases in the treatment of syphilis.

1. To excite the retarded outbreak of local appearances on the skin, the eruption of roseola, to bring to light the latent and often only suspected presence of syphilis: this may be of importance in many cases, especially if one starts with the sound principle, only to subject to a specific treatment, cases in which undoubted symptoms of the disease have been obtained.

2. Warm and hot baths give support, in a certain sense, to the specific cure. It is believed, that the power of the skin to take up the mercury that is rubbed in, is increased by frequent and hot bathing. This may be the case. But, on the other hand, it can scarcely be denied that still more mercury is taken up, if the ordinary practice is followed, if the mercury is left on the skin, and a bath is taken only every 4 to 6 days. Possibly hot baths (vapour baths), which raise the temperature of the body and increase the decomposition of the albuminates, may assist the action of mercury in syphilis.

3. Warm baths, employed along with a specific treatment, have sometimes a favourable influence in hastening the cure of certain skin affections, in healing rupia, destructive dermatitis, psoriasis, &c. They may also favour the disappearance of other symptoms, various ones on the side of the glands, the periosteum, the bones, and the nerves, &c. (cephalæa, dolores osteocopi, agrypnia), headaches, pains in the bones, sleeplessness.

4. Various baths and drinking cures are adapted for those cases of inveterate syphilis, where the patients have been pulled down in consequence of injudicious mercurial and iodine

courses (by too long continued cures, by chronic mercurialism or iodism, by incomplete cures following too closely on each other, by mixed mercurial and iodine cures), and, although constantly getting fresh relapses of syphilis, have not constitution enough to respond any more to mercury or to iodine. The improvement of the constitution by bathing and drinking cures, as well as by the use of milk and cod-liver oil, often produces the result, that after their use the mercury, which had lost its power, again developes its specific curative action.

Various baths and drinking cures (brine baths, salt drinking cures, iron baths, indifferent thermals), as well as climatic cures and sea baths, are ordered with success as an after-cure of mercurial treatment, or to remove a few residual symptoms of syphilis (skin affections, enlargements of glands, affections of joints and bones, &c.)

If we inquire which baths and drinking cures best fulfil the indications which have just been laid down, we must in the first place reply, that no specific action is to be expected from any group of waters.

Everywhere, when warm or hot baths, and sometimes vapour baths, are methodically employed, and mercurial cures are conjoined with them judiciously, that is, according to the particular case, the same success is obtained. The great reputation which the sulphur baths have in the treatment of syphilis, has led bath specialists to the mistaken conclusion, that such baths have a special or particularly favourable operation in syphilis. The motives of such pretensions, as well as the proofs of their erroneous nature, are not far to seek.

All thermals are suited for the treatment of constitutional syphilis in its different forms; the indifferent thermals are just as good as the sulphur, the calcareous, or the soda thermals, &c. Brine baths (brine thermals), with the use of which drinking cures can be combined with advantage, are useful in many cases (*Kreuznach*, *Hall* in Tirol, *Soden* near Aschaffenburg, &c.)

For those cases in which the chief indication is to improve the general condition, climatic cures, the use of indifferent thermals in the mountains, milk cures, sometimes sea baths also, deserve to be preferred to sulphur baths, especially to those which are situated in crowded towns.

Among drinking cures, washing-out warm water cures (indifferent thermals), salt drinking-wells, and in certain cases the saline iron waters, are also employed with advantage.

Among the sulphur baths especially recommended for the treatment of syphilis, are, *Aix-la-Chapelle*, *Burtscheid*, *Baden* near Vienna and in Aargau, *Mehadia* (Herkulesbad), *Schinznach*, the sulphur thermals of the Pyrenees, Hungary, &c.

XIV. CHRONIC METALLIC INTOXICATION.

(SATURNISMUS, HYDRARGYROSIS.)

The treatment of chronic metallic poisoning, has for its object, to induce the excretion of the metal from the body, and to remove the changes in the organs which have been caused by the metals (the anæmia and cachexia, the lead paralysis, contractions and atrophies of muscles, pains of the joints, neuralgia, the lead or the mercurial tremors, inflammatory changes in the periosteum, the bones, the mucous membranes, the joints, &c.)

1. The drinking cure is generally used in conjunction with bathing. The elimination of metals is aided by copious water drinking. In this it is all one, what may be the chemical constituents of the water. The indifferent thermals answer for this purpose just as well as the warm alkaline, the alkaline saline, the salt or the sulphur waters. The drinking cure is a simple washing-out of the system, in which the amount of salts present is entirely unimportant, unless so far as it favours the power of diffusion through the tissues. This last point is in favour of salt water drinking. The sulphur waters enjoy a special renown (*Aix-la-Chapelle*, *Burtscheid*, *Nenndorf*, *Eilsen*, *Weilbach*, *Wipfeld*, *Baden* near Vienna and in Aargau, the Hungarian and Pyrenean sulphur wells, &c.; although it is very questionable whether the sulphur of those wells has any specific action that favours the elimination of mercury or of lead (pp. 411, 412).

Drinking cures with the bitter waters suit some cases of lead poisoning (*Friedrichshall*, *Saidschütz*, *Alap*, *Ofen*), or the alkaline saline waters (*Karlsbad*, *Marienbad*, *Tarasp*, *Bertrich*, &c.), especially when the digestion and the bowels are disordered. I must further bring forward the salt drinking cures

(in connection with brine baths), in which one may suppose that those containing iodine, might be preferred for hydrargyrosis. Cures at *Kreuznach*, *Kissingen*, *Soden*, *Hall* in Tirol, *Salzschlirf*, *Wiesbaden*, *Homburg*, &c., may be recommended. In other cases where the anæmia is prominent, much weight is laid by many on the iron wells, for curing the cachexia.

2. Bathing cures (usually united with drinking ones) are powerful agents in helping to eliminate the metals, as well as in improving the general standard of nutrition and in curing certain sequelæ of metallic intoxication. The hot forms of baths (vapour baths), besides exciting the activity of the skin, and diaphoresis, occasion increased breaking down of albumen. Perhaps a portion of this favourable effect in such cures is to be attributed to this. Here too the solid or gaseous constituents of the baths play an entirely subordinate part, and it requires an intense degree of credulity, to be able to attribute any specific influence to sulphur thermals.

The indifferent, the calcareous, the alkaline, and salt thermals, the brine baths, and waters highly carbonated, are at least as useful as the sulphur thermals, in the methodical treatment of chronic metallic poisoning.

Peat and slime baths, peat cataplasms, local baths, vapour douches, sand baths, can be used for some of the symptoms of lead poisoning, as paralyses, contractions, neuralgias of the joints, &c.

For an after-cure, especially to remove anæmia, and to raise the broken-down system, climatic cures are especially valuable in connection with milk cures, and sea baths are suited for some cases.

XV. SKIN DISEASES.

As has been pointed out above (pp. 385, 386), only some of the many skin affections are suitable for bath cures. Some of these are: psoriasis, prurigo and pruritus, pityriasis versicolor, seborrhœa sicca, furfuracea, acne, hyperidrosis, anidrosis, ichthyosis, urticaria chronica, furunculosis, erysipelas chronica, some chronic eczemas, torpid, badly granulating wounds and ulcers of the skin, fistulous suppurations of glands in scrofulous cases, &c.

Long-continued baths, such as are given at Leuk, act particularly favourably in many such cases.

On the other hand, most of the eczemas, especially the acute, the moist, the papular, the vesicular and the impetiginous, eczema rubrum squamosum, the subacute and chronic eczemas, with irritable skin, with tendency to spread, and to acute exacerbation, are not adapted for bath treatment. The skin-stimulating brine and the highly carbonated waters are positively injurious in such cases.

The following baths are recommended in the above-named affections :

1. The indifferent thermals: *Wildbad, Gastein, Ragatz, Schlangenbad, Teplitz*, &c.

2. The calcareous thermals : *Leuk, Weissenburg.*

3. The sulphur thermals. There is no foundation for the popular belief in the special efficacy of sulphur baths in skin affections.

4. The brine baths or salt thermals. They are especially recommended in chronic scrofulous exanthemata. They sometimes occasion an acute exacerbation with spreading of the eczema, and must then be given up. In other cases they operate beneficially, especially in the sparsely disseminated impetiginous form of eczema ; whereas all the forms just enumerated above, are always made worse by brine baths. Besides salt baths, the alkaline thermals (*Ems, Neuenahr, Bertrich*), as well as the iron baths, are recommended.

Peat and slime baths are suitable for torpid ulcers and for badly granulating wounds.

After the cure of skin diseases, brine baths, sea baths, climatic cures, and occasionally the cold water cure, are employed to ‘strengthen and harden the skin.’

The selection of a drinking cure in skin affections depends on their cause, or on the accompanying circumstances (scrofula, anæmia, gout, diabetes, general over-nutrition ; for instance, in acne rosacea). According to the nature of the case, salt, iron, alkaline, alkaline saline, or bitter waters, must be employed.

As regards the balneotherapeutic treatment of scrofulous exanthemata, by drinking cures, milk cures, climatic cures, sea bathing, what was said above about scrofula (pp. 463, 464) is applicable.

INDEX.

END OF THE FOURTH VOLUME.

Spottiswoode & Co. Printers, New-street Square, London.